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JUNE 1995

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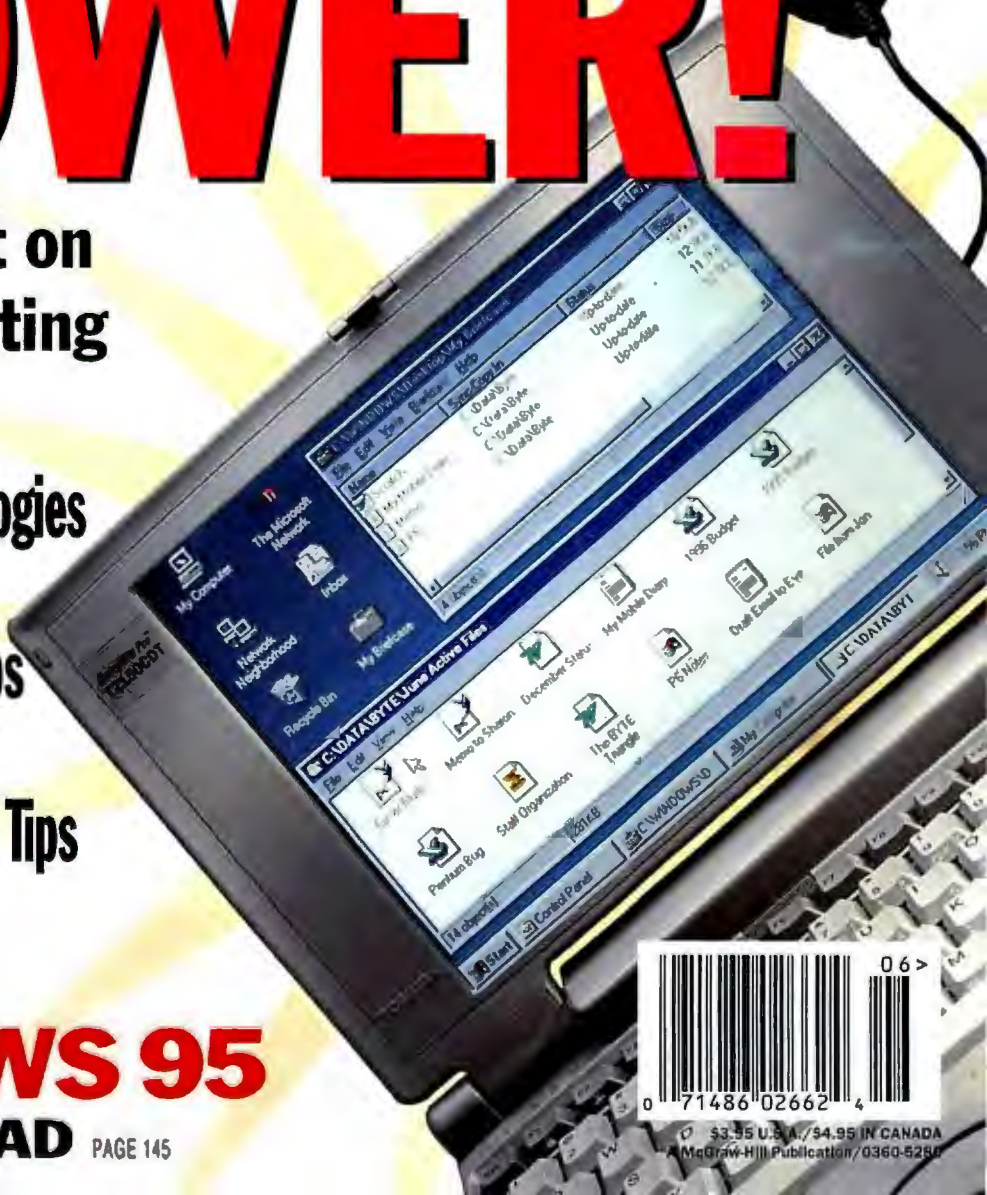
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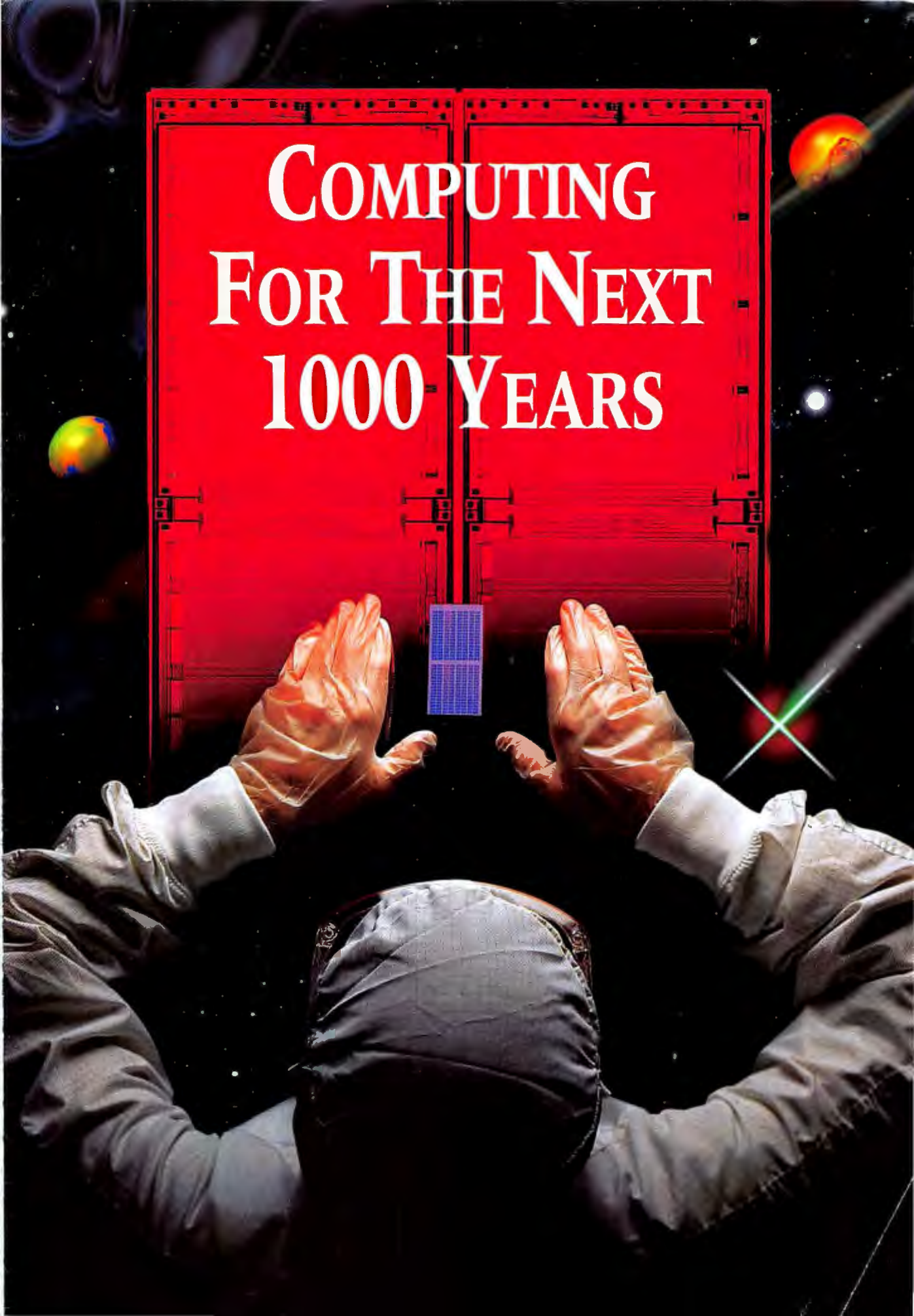
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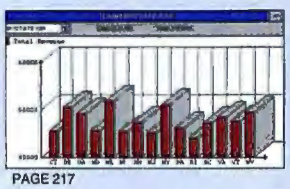
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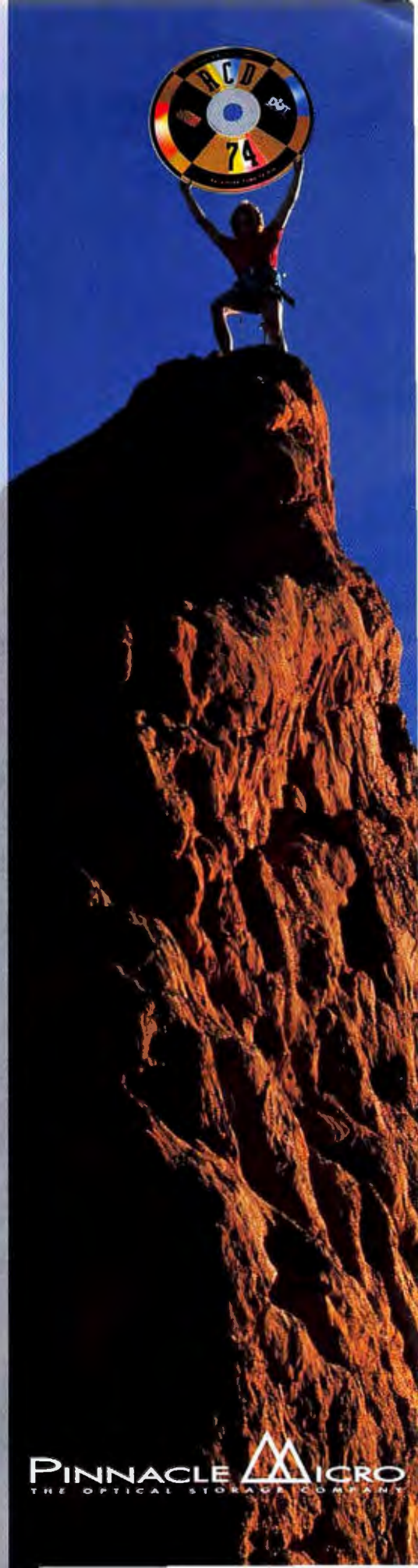
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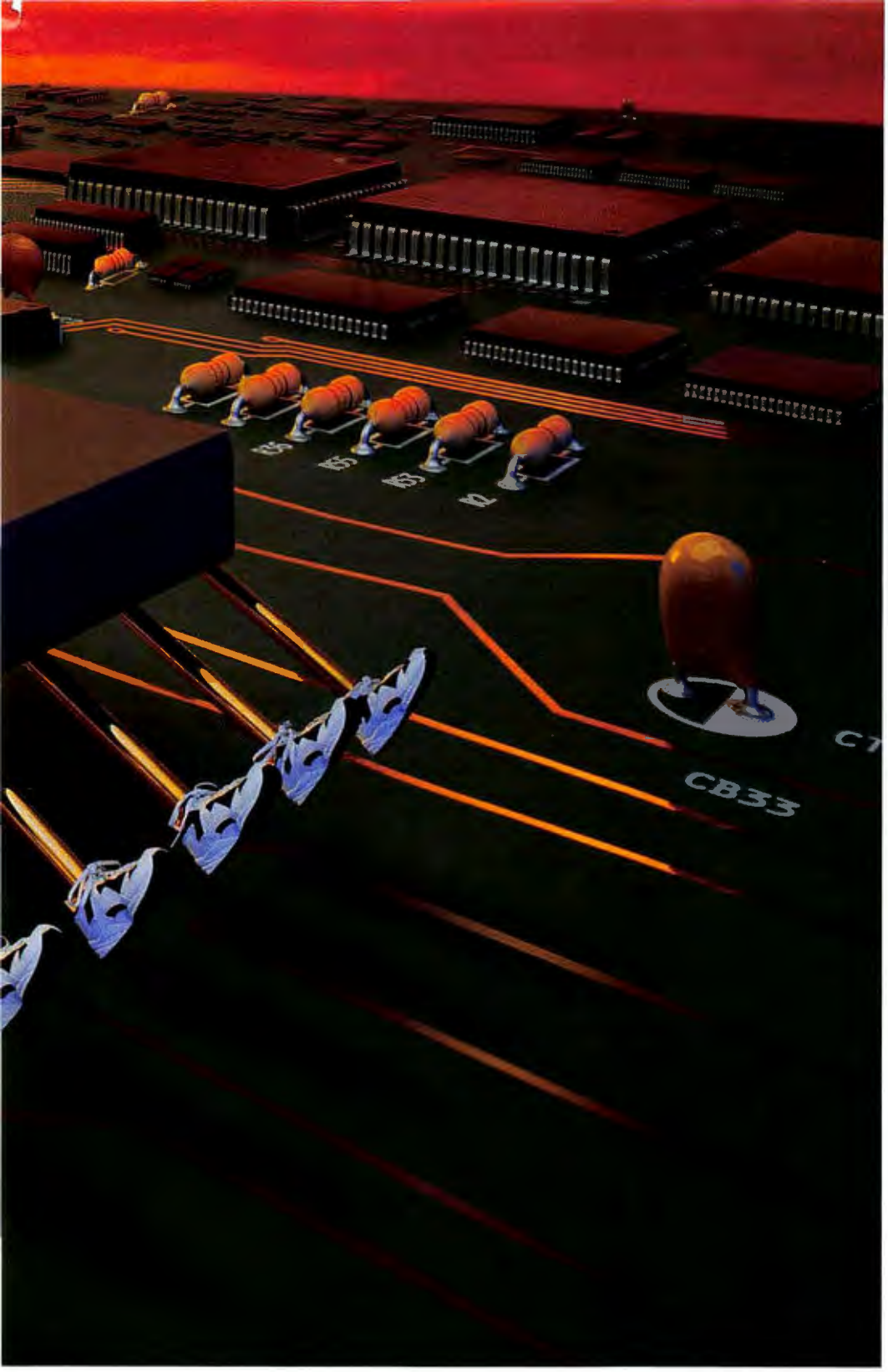


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Take This Job and Lug It



Portable computers: liberator or leash? It depends on how you use them. Don't forget the off switch!

Every now and then when I find myself among new acquaintances, somebody will lob me a variation of The Question. And they look to me for The Answer.

Question: What are computers going to be like in the future? My close friends know better than to ask me this, because The Question is really an entrée to wax philosophical about all sorts of silly, far-out notions that get most technologists rolling their eyes and looking about for more grounded conversation. Without a time frame to anchor my discussion, you see, when I talk about the future I start talking about implanted computers, discussion databases that the global population has access to (the Internet doesn't yet count), and stuff like that. Out-there concepts, spawned from the time frittered away in youth reading bad science fiction (unlike, say, Mr. Pournelle's *good* science fiction).

Except we're closer to the future than we might want to admit. None of us at BYTE have implanted computers, but the way some of us take our portables anywhere, they might as well be. Dave Egan, our publisher, has been known to take his portable on vacation, although he had to hide it in his luggage so his daughter didn't see it. (She hates "that thing" that diverts his attention from family.)

My portable goes with me everywhere, too (well, *almost* everywhere). People ask me how I can do this, and if I ever leave my work behind. They're making a fundamental mistake: The computer is not work. It's just a tool that gives me access to other people. Some of these people are the ones I work with, but others are my friends, my family, and people I haven't even met in person.

Yes, portable technology can act as nothing more than a cruel leash back to the office. But fortunately, every piece of technology we cover in BYTE has an off switch, which we should be liberal in using during moments that require our undivided attention to other, nontechnological matters.

Off switch or no, I'm totally hooked on portable technology. I'm never in one place long enough to get comfortable with wired-in devices (desktop computers, corded phones, cable television), and furthermore, I like being able to compose my E-mail to friends and acquaintances from the relative seclusion of an airline seat (to those of you who've gotten E-mail replies from me, I thank you for sparing me from the tedium of yet another showing of *Angels in the Outfield*).

And beyond the connectedness I get from having my portable with me everywhere, I get a kick out of portable computers because they highlight real engineering prowess. I like the innovative IBM 701C (Butterfly) keyboard. I like the ridiculous three-way door that covers the PC Card slots on the new Toshiba Satellite Pro (the machine on this month's cover). I even like the little LED bar graph on the Dell Lattitude's lithium-ion batteries—a feature I doubt anyone needs, because one battery is plenty for most users, and you can't see the LEDs when the battery is installed in the computer. You just don't see this kind of attention to detail on many desktop computers, where the engineers have sheet metal to spare and where cleverness of packaging is not a major design consideration.

But to be fair, here's what still nags me about this class of technology: Mostly, it's too bloody expensive. I want all computer users to experience the freedom of untethered technology, but I don't recommend portables for most individuals because you have to give up too many features to take your show on the road. And furthermore, you don't have access to quite the same bandwidth of a hard-wired desktop connection from the Motel 6 in Sedona, Arizona. But that's an infrastructure problem—I'm sure if most hotels had ISDN connections, there would be a flood of ISDN PC Cards on the market.

For those of you who understand the all-consuming addiction to mobile technology, you'll be happy to see our Special Report on Mobile Computing. In addition to covering some of the hottest portable products you can buy today, we also look at what Windows 95 means to the mobile user, and we examine several technologies you can't get for any price, just yet. It all starts on page 97. ■



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Introducing the new Compaq ProLinea

The original premise was simple: make a powerful, yet affordable, computer that doesn't come with all the headaches normally associated with the word "value." And in creating the latest Compaq ProLinea, we built on that premise—by taking the original apart.

We examined it from top to bottom, from the inside out, looking for ways to improve it. Looking to see what new technologies we could add.

THE LATEST PROLINEA HAS AN IMPRESSIVE SAVE FEATURE: IT'LL SAVE YOU MONEY, SAVE YOU TIME, AND SAVE YOUR SANITY.

In the end, we came up with more than a few improvements. Making ProLinea even harder to distinguish from more expensive machines. The fastest processors. Easy upgradability. Simplified maintenance. Features that make it easy to live with on the day you install it, and for years to come.

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It all raises ProLinea to a completely new level. (Of course you'll still find the price within reach.)

And that should certainly put your mind at ease.



LIKE MOST PC BUYERS, YOU'RE "BETTER VALUE," SO WE'VE CLEVERLY

Traditionally, the phrase "better value" has always meant someone's cut corners to give you a better price. At Compaq, however, we like to take a different approach.

The result is the new Compaq ProLinea: a family of computers that not only offers affordable prices, it pushes technology many steps ahead. Twelve, to be exact:

Number One. Our first improvement is something you'll notice before you even buy a ProLinea. You get to choose the processor you want—from very fast (486DX2/50MHz) to blindingly fast (Pentium/100MHz). This way, you don't have to buy more performance than you really need. And it's designed so that you can upgrade whenever you want.

Number Two. You may be familiar with the new standard bus architecture called PCI. Basically, it improves upon the previous technology by expanding the data path to 32 bits and radically speeding the flow of information to expansion cards and peripherals. And guess what: Compaq has already enhanced this standard with our new TriFlex/PCI architecture—which is built into every ProLinea model.

Number Three. The PCI architecture also boosts the performance of the graphics subsystem. So even if you're working with general productivity applications like word processors and spreadsheets, you can enjoy a crisp, responsive high-resolution display. If your uses demand more, select 586-class models are now available with higher-performance VRAM graphics.

Number Four. Forgive the acronyms, but there's also a PCI local bus IDE interface. This not only pays off in improved disk performance, but it supports up to four storage devices. Which means you can easily add another hard drive, tape backup or CD-ROM drive when needed.

Number Five. As long as we're on the subject of CD-ROM, multimedia ProLinea models now come with our new QuadSpeed drive (along with Enhanced Business Audio). This gives you faster access to the rich and vast references available on CD-ROM today, from national directories to archives of business publications.

Number Six. However large a hard drive may be, there are those who take it as a personal challenge to fill it up. With the new ProLinea PCs, however, we're determined to make that as difficult as possible. You can choose a configuration with a disk capacity of 270MB, 420MB or 720MB. Any of which should put you well ahead of your burgeoning files.

Number Seven. ProLinea comes with 8MB or 16MB of RAM, depending on the model. And you can easily expand it to 136MB or 192MB—enough to take advantage of new 32-bit operating systems, run several programs at once and work with spreadsheets the size of Madison Square Garden.

Number Eight. ProLinea is filled with features designed to make your life

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easier. It's not only pre-loaded with an extensive online help system and automated setup software, it now has redesigned documentation to help you quickly pinpoint information. It's also optimized to run new operating systems like Windows 95, which will make your future computing easier still. Every model supports the Plug-and-Play standard that will bring a new simplicity to the process of adding expansion cards. (If you add a new network interface card, for example, ProLinea will sense the change and automatically reconfigure its software to support it.)

Number Nine. You decide exactly how expandable you want your ProLinea to be. You can select a desktop model with three expansion slots and three expansion bays or a model with four of each. Or you can choose a five-slot, five-bay mini-tower model that offers maximum expandability without taking up too much of your space.

Number Ten. The new ProLinea PCs have been designed so you can get inside without any special tools. The system board slides out to accept extra memory or a processor upgrade. The hard drive cage swings out so you can swap disks without reaching into inaccessible, finger-bruising areas. And when you snap in a new Compaq hard drive, you won't have to configure any enigmatic jumpers. When you connect the cables, the settings have the good sense to take care of themselves.

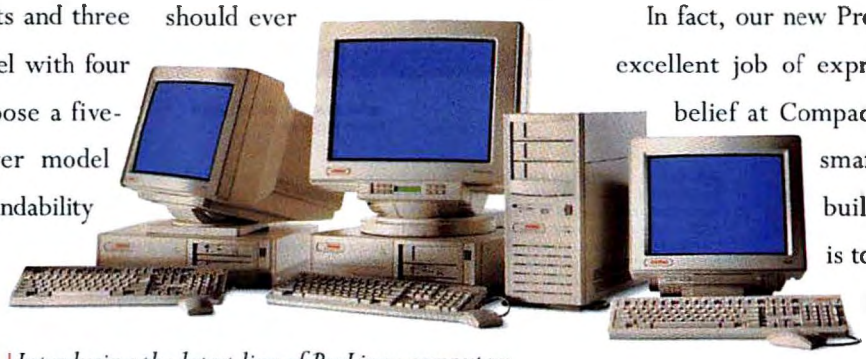
Number Eleven. The ProLinea system board now incorporates Flash ROM technology. That means basic system ROM can be updated without major PC surgery. If future system updates should ever become necessary, installing them will be no more difficult than running a software utility and clicking a few buttons on the screen.

Number Twelve. And what about the environment? Using a ProLinea won't by itself repair the ozone layer, but it's certainly a step in the right direction. For the sake of the atmosphere—and everyone who breathes it—our PC manufacturing process is completely CFC-free. And every model is now Energy Star-compliant, which means less wasted energy for the planet and less wasted money on your power bill.

These are the improvements that define our approach to value. (We think you'll agree, it's a lot more rewarding than cutting corners.)

In fact, our new ProLinea does an excellent job of expressing a core belief at Compaq: That is, the smartest way to build better value is to build a better computer.

PROBABLY SICK OF HEARING DISGUISED IT AS 12 IMPROVEMENTS.



Introducing the latest line of ProLinea computers

As with all Compaq PCs, ProLinea is covered by our free 3-year limited warranty. For more information on our full line of Compaq desktop PCs, call us at 1-800-345-1518 or reach us on the Web at www.compaq.com. In Canada, we can be reached at 1-800-567-1616. © 1995 Compaq Computer Corporation. All rights reserved. Compaq and ProLinea registered U.S. Patent and Trademark Office

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Letters

Intel's P6

I enjoyed your article "Intel's P6" (April); however, the P6 is not the first chip "intended for large-scale production" with two dies on a single package. That honor goes to the DEC J-11 11/70-on-chip. The J-11 was the first PDP-11 (maybe the first chip of any type) to be able to do register-to-register instructions in one cycle (200 nanoseconds), and it had a four-level pipeline, truly great accomplishments in 1982.

Bob Morris
President
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I really enjoy the depth to which BYTE explores topics like the P6. I still have a few questions regarding your April Cover Story. On what front-end bus speed (½ CPU, ⅓ CPU....) does Intel base the P6's performance numbers? Also, I was under the impression that a 100-MHz Pentium really runs at 99 MHz. This would make it easy to use a PLL (phase-locked loop) to create 66 MHz for the main bus. It follows that the P6 would use a 132-MHz clock rate so the main bus would run at 66 or 33 MHz.

Karl Richards
richardk@execpc.com

The P6's I/O (i.e., frontside) bus can be clocked at ½, ⅓, or ¼ of the core speed. The performance estimates from Intel are based on a system that runs internally at 133 MHz and externally at 66 MHz. In other words, ½ clock speed. It doesn't make sense to run a 133-MHz P6 at ⅓ or ¼—those dividers were included for future P6 chips that will run at faster core speeds. My understanding is that a 100-MHz Pentium actually runs at 100 MHz, not 99 MHz, and that a 133-MHz P6 runs at 133 MHz, not 132 MHz.

—Tom R. Halfhill

In your April Cover Story you describe the physical dimensions of the current crop of processor chips as "306 mm square." That comes very close to being a foot on a side. We'll have to redesign all our personal computers just to hold the CPU. This is too much!

Merritt J. Rucher
Belen, NM

Yes, the size was supposed to be written as "square millimeters," not "millimeters square," but somehow it got transposed. *—Tom R. Halfhill*

They're Everywhere

In Tom R. Halfhill's March piece, "The Truth Behind the Pentium Bug," his instructions on how to bruise an integer (page 164) are mind-boggling. I tried the test on several different Pentium machines and they all gave me the binary 10 from the difference of 4.1 and 1.1. When I tried it on our newest Pentium 100, I got the same binary, 10. All our 486 machines gave me 10 as well. I tried a different test I acquired from another magazine and found which systems were using a faulty chip. I wonder if Intel is replacing Pentium chips that are not faulty at all?

Cesar Quebral
Legend23@ix.netcom.com

Integer bruising happens on almost all computers, not just a buggy Pentium. The example I gave was not to reveal whether or not you've got a bad Pentium but to demonstrate how integers can get bruised on any computer. *—Tom R. Halfhill*

Mutant Methods

I found your March Editorial "Mutant Chips," in which you told us not to be overly concerned about the Pentium bug and also implied that we wouldn't want to fly with an airline that was programmed using heuristic methods, to be something of a giant leap from reality. According to published reports, between 40 percent to 60 percent of all pilot-reported faults are not corrected at the depot repair shops. These randomly occurring failures (bugs) are generally referred to as CNDs (Can-Not-Duplicates). CND rates usually increase as multiple unrepaired faults accumulate.



You think we're asking for trouble if we use neural networks; we've got trouble already. If pilots or autopilots rely on the data from the avionics equipment to fly the plane safely, and half or more of the faults are never fixed, how safe are airplanes really? The diagnostic problem gets worse as avionics become more complex. Complexity demands that we use neural networks and other heuristic methods, if not as the final solution, then to help us figure out a more direct means to sort it all out.

Brent Sorenson
Vice President, Research and Development
Universal Synaptics
Ogden, UT

Bob's Neighborhood

You make the point that users raised on Bob will have certain expectations ("The In-Your-Face Interface" April Editorial). I suggest that users raised on Bob won't have the required skills to figure out real-world applications. Like most kids' toys, Bob will end up forgotten in the closet after several weeks. In fact, if we ever do see users raised on Bob, they will most likely resemble people raised on TV: semi-literate, jingle-humming boobs.

Steve Rogers
scrogers@winternet.com

People said the same thing about GUIs, the same thing about the command line, and for all I know, the same thing about assembly code. ("The only real way to use computers is in binary!") Computers should be easier to use, not harder. While Bob doesn't suit my personal tastes in interfaces (nor yours, obviously), if it forces programmers to write easier-to-use applications, I'm all for it. *—Rafe Needleman*

I was browsing in a software store and asked about the huge, rotating yellow smiley face that bore the words "Bob is coming." The clerk was quick to hand me a brochure, and after I read it, I became irked, annoyed, and dismayed—but not surprised. Bob wasn't an intelligent agent. Bob was a kiddie interface that makes an ATM look smart. Many successful GUIs obscure the real functionality of the computer from people in an effort to make the computer easier to use. That is appropriate when the OS can do the bookkeeping, but Windows can't. Windows programs put files in the \windows\system directory without telling you, and when you delete the applications, those files are still there.

We want to hear from you. *Address correspondence to Letters Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458; or you can send E-mail via the Internet or BIX to editors@bix.com. Letters may be edited.*

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Circle 70 on Inquiry Card (RESELLERS: 71).

The last thing we need is another layer between naive users and Windows.

Stuart M. Pomerantz
smpst19@vms.cis.pitt.edu

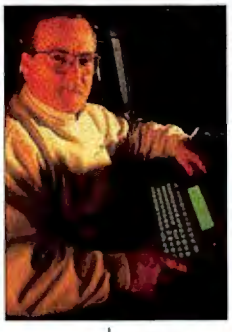
BYTE: Real Food for Real People

I'm reading my April issue and I am grateful! This issue exemplifies why I originally subscribed to BYTE: articles with meat that explain the technology. I was afraid you were going to become another reviews magazine. BYTE is back to what it was for me: a solid education.

John Astreides
IS Support Systems
Gottlieb Memorial Hospital
jastra@ais.net

Moving the Rock

Your March Cover Story "New Ways to Learn" was an excellently conceived, brilliantly executed article and a great service to those of us who slug it out in the process of moving the rock. I need to present the keynote to the umbrella organization for educational leadership here in Maryland, and my task will be much easier by the ripple in the information environment your article caused. I can just hear all the people in school systems ripping it out, digesting it, and including your ideas in their reports.



Jack N. Cole
Columbia, MD

When I read "New Ways to Learn," I was looking for something we could actually apply in the real world of reduced educational budgets. All I found were expensive alternatives to human contact. Andy Reinhardt suggests the federal government pick up the $8 billion to $9 billion cost to connect every school in America to the data highway. Connecting the schools is only the initial cost. Does anyone really believe that this country will provide such funding when most classrooms don't even have a telephone?

Martin Hittelman
Los Angeles, CA
MartyHitt@aol.com

Proud Papa

I have been a contract engineer for Rockwell-Collins for almost seven years. One of the systems I gave heart and soul to was the Rockwell Pro2000 series described in Christine White's "On-Road, On-Time, and On-Line" in the April issue. It's rare when the big magazines, such as BYTE, cover such systems, and the gratification I felt while reading about the Pro2000 caught me by surprise. Thank you very much.

Greg Shelton
Cedar Rapids, Iowa
glshelton@bix.com

The Real Compatibility Test

Sal Salamone's "Compatibility Testing" (April), in which he explains his method of discerning personality traits by studying a person's computer habits, had me a little worried about my software-shopping husband, until I realized there is a fatal flaw in Sal's theory. In order to determine how a potential mate will treat you, it's necessary to observe his interaction with his hardware, which is, after all, the core of the relationship.

When I applied this new approach, my fears were gone. Although he has had numerous opportunities to purchase a Pentium, my man stands by his Dell 486. All that software he buys for it indicates that he is generous and giving to those he loves. If he feels his computer should have the biggest, highest-quality hard drive, by the same token he'll feel his wife should have the newest, nicest luxury car. If the way he treats his computer is indicative of how he'll treat me, I'll be happy for a long time.

Debi Littlejohn Shinder
Little Rock, AR
MsSgt@aol.com

Throwing Eunuchs Out of Windows

Just wondering: If I replace Windows with Unix, have I been emasculated or defenestrated?

David Boyce
Cambridge, MA
dsb@id.wing.net

FIXES

"The 1995 Readers' Choice Awards" (May) should have listed Intergraph's fax number (page 80) as (203) 730-9441.

In the April Lab Report, the AST Ascentia 910N notebook has a maximum internal screen resolution of 640 by 480 pixels by 65,536 colors, not 600 by 800 pixels by 256 colors, as stated on page 199. The WinBook XP notebook now supports a maximum hard drive capacity of 800 MB, secondary cache is not yet available for it, and its optional 16-bit sound card plugs into the notebook, not into the docking station.

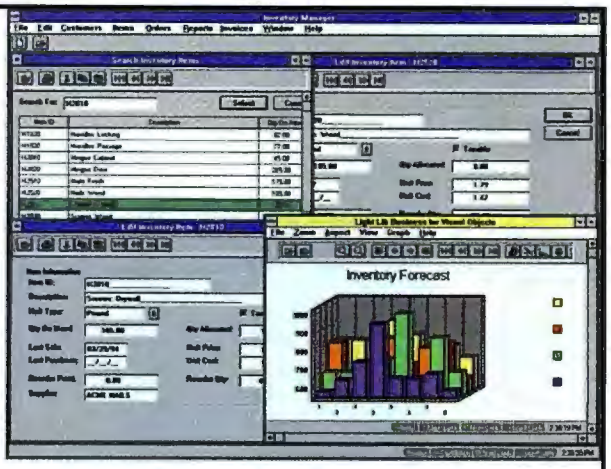
Rick Grehan's E-mail address (April, page 216) is rick_g@bix.com. Lenny Tropiano's E-mail address (page 74) is lenny@icus.com, and his URL is http://www.icus.com/~lenny/.

In the "Whatever Happened to..." article concerning diamond-film hard disks (April, page 32), there is an error in the gender designation of Ainissa Ramirez. He should be she. ■

COMING UP IN JULY

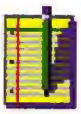
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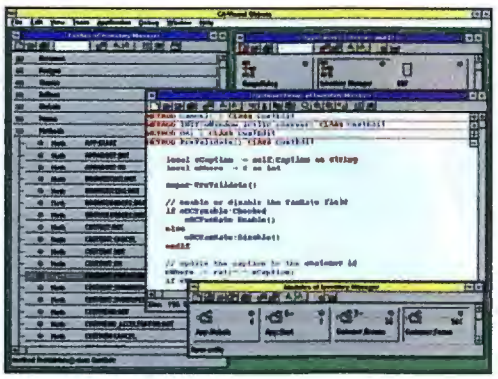








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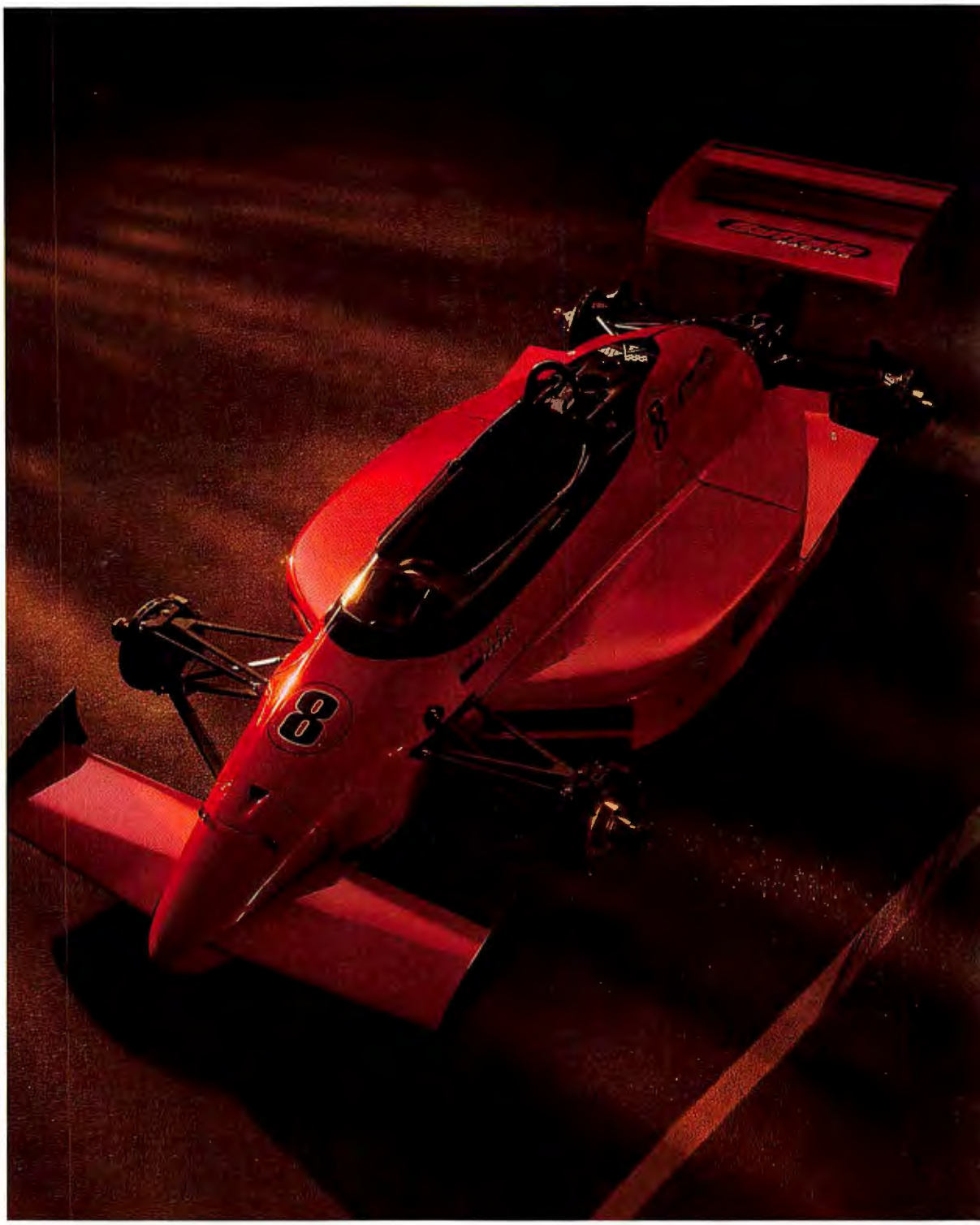
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8

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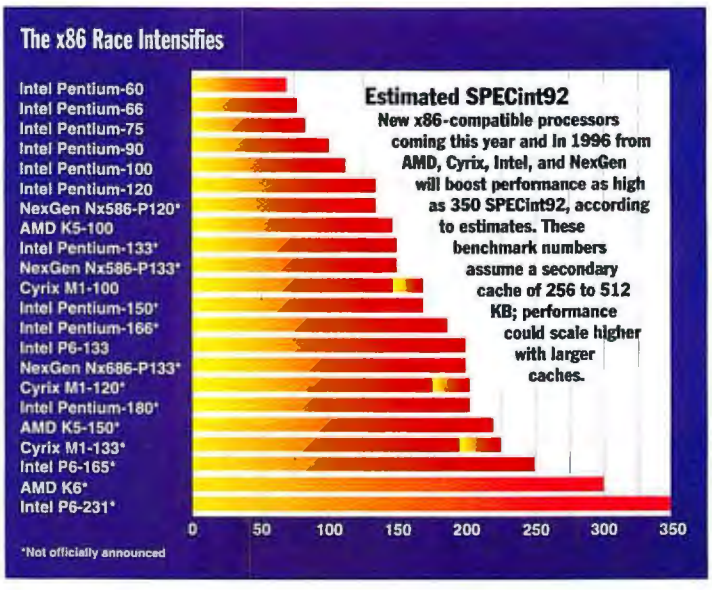
PC MICROPROCESSORS

Chip Wars Drive Down PC Prices

Prices will drop and performance will increase as Intel faces some strong competition in the x86 microprocessor arena

TOM R. HALFHILL

Four companies are currently scrambling to put the fastest x86 chip in your PC in 1996, and the competition will make lightning-fast PCs more affordable than ever. Even as Intel (Santa Clara, CA) prepares to introduce its sixth-generation CPU this year (see "Intel's P6," April BYTE), the company is also working on fifth-generation Pentiums that will run as fast as 180 MHz. Meanwhile, Intel announced a 120-MHz Pentium in March. Faster versions of the Pentium processor—clocked at 133 and 150 MHz—are promised for the end of this year. In addition, Pentiums clocked at speeds of 166 and 180 MHz are expected to follow in 1996.



A 180-MHz Pentium would likely break the 200-SPECint92 barrier and deliver roughly the same performance as the first P6, which is clocked at 133 MHz. By then, of course, the P6 will be faster, too. Intel plans to introduce a 166-MHz P6 in early 1996 and a 231-MHz version later next year. That would yield an estimated top end of about 350 SPECint92, which would boost the P6 into the stratosphere of the fastest RISC chips.

Leading the charge among Intel's rivals is NexGen (Milpitas, CA), which won a great deal of credibility last year by shipping its first Pentium-class x86-compatible processor, the Nx586. (Compaq recently announced it will use NexGen chips in future PCs.) NexGen says it will match the performance of Intel's 120- and 133-MHz Pentiums by midyear, when it delivers P120 and P133 versions of the Nx586.

NexGen's P120 chip will actually be clocked at about 112 MHz, and the P133 at about 124 MHz, but their performance will be comparable to that of the slightly faster Pentium chips, due to the NexGen chips' more efficient microarchitectures. NexGen's strategy is to match the Pentium's performance while undercutting Intel's prices. The Nx586 currently costs about 13 percent to 20 percent less than comparable Pentium versions.

NexGen's Nx686, a sixth-generation design, will compete head-to-head with Intel's P6. NexGen says it will introduce the still-secret Nx686 "in the same time frame" as the first shipments of the P6, which are anticipated for late this year. According to NexGen, the Nx686 will match or exceed the P6's performance.

Cyrix (Richardson, TX), another x86 contender, hopes to release by midyear the M1, a 100-MHz x86 chip that promises to deliver 30 percent to 50 percent more performance than a Pentium running at the same clock speed. Cyrix says that a 120-MHz version of the M1, slated for release at the end of this year, will be followed by a 133-MHz chip in early 1996. If Cyrix can meet those goals—its delivery schedules have already slipped—the M1's performance at 133 MHz should reach 200 SPECint92, which is comparable to the performance of the 133-MHz P6 and the 180-MHz Pentium.

Intel's largest x86 competitor, Advanced Micro Devices (Sunnyvale, CA), promises to ship its K5 processor in early 1996. Like the Cyrix M1, AMD's K5 is estimated to be at least 30 percent faster than a Pentium running at the same

clock speed. The K5 will debut at 100 MHz; a 150-MHz version will follow. The 150-MHz K5 should easily exceed 200 SPECint92 and compete well against Intel's 133-MHz P6 and 180-MHz Pentium. AMD says that later in 1996 it will unveil the K6, a sixth-generation x86 processor that will attain 300 SPECint92—performance comparable to that of a 200-MHz P6.

Recent history is a good bellwether of how fast system prices will drop due to all these manufacturing improvements: Pentium systems fell below $2000 about twice as fast as 486 systems did after the 486 processor was introduced. It's likely that sixth-generation x86 performance will be affordable by 1997.

CHIPS TO DIE FOR

New fabrication plants and process technologies that shrink processor dies allow the development of chips that run faster and at lower voltages without overheating. Smaller dies also let fabricators squeeze more chips onto a silicon wafer, thereby increasing yields and slashing costs.

Intel is already moving the 120-MHz Pentium chip onto its next-generation 0.35-micron process. Faster Pentiums will be manufactured on this process, too. Slower 60- to 100-MHz Pentiums (and some 120-MHz chips) will still use the older 0.8- and 0.6-micron technologies.

The only other x86 maker that has its own fabrication plants is AMD. Cyrix and NexGen subcontract their manufacturing to other chip makers (Cyrix and NexGen both subcontract with IBM Microelectronics, and Cyrix also deals with SGS Thomson). Intel designed the P6 to run at higher clock speeds to exploit the company's advantages in fab capacity and process technology.

To match Intel's clock speeds, AMD is working hard to catch up with Intel and move its K5 onto a similar 0.35-micron process. "We're moving to 0.35 so fast that there will possibly be a mix of both [0.5- and 0.35-micron] parts at first," says Drew Dutton, AMD's strategic marketing manager. "In fact, depending on the timing, we may go entirely with 0.35."

NexGen's Nx586 is manufactured on IBM's 0.5-micron process but isn't optimized for it. NexGen hopes to optimize the design and shrink the Nx586 from 192 square millimeters to 118 mm^2 by midyear so that the chip will run as fast as Intel's 120- and 133-MHz Pentiums. NexGen says it will move the Nx586 onto IBM's 0.35-micron process late this year, which will reduce the die further and allow clock speeds of over 150 MHz. The Nx686 will probably appear on this process as well.

Cyrix faces the biggest manufacturing challenge. The 100-MHz M1 will debut on IBM's 0.65-micron process, yielding a monstrous die of 394 mm^2, which is larger than that of any general-purpose CPU. Yields will be so low that analysts wonder how Cyrix will make a profit on the chip. Cyrix says it will decrease the die size to 225 mm^2 later this year by using five layers of metal instead of three. In early 1996, the M1 will go on another diet, reducing to a much-more-competitive 169 mm^2 by migrating to IBM's 0.5-micron process. This will also enable clock speeds of over 133 MHz. **—T.R.H.**

POWERPC

PowerPC Tidal Wave

This spring and summer, Apple, IBM, and other companies will introduce the first Macs based on the PCI (Peripheral Component Interconnect) bus, the first PowerPC-based ThinkPad, and new PowerPC systems from IBM. In addition, PC manufacturers and peripheral makers will announce their entry into the Power Mac market. Farther out on the horizon is IBM's OS/2 for PowerPC, which is not expected to ship until later this year.

Apple will reportedly introduce three PCI-based Macs, code-named the Tsunami, the TNT, and the Nitro. Apple declined to comment on the systems, but sources say the Tsunami will represent the high end of PCI-based systems and will target high-end desktop publishing and 3-D applications.

With Apple's move to PCI, the options that users will have for third-party graphics accelerator boards should increase. Apple is reportedly developing its own PCI-based graphics accelerator board, but the company will be joined by several others, including Radius and well-known PC peripheral card makers, such as Matrox.

"Power Mac users will get a more competitive mix of products to choose from," says Mary Ellen Power, communications manager for Matrox (Dorval, Quebec, Canada). Matrox's new Millenium board for the Mac will offer QuickTime video, QuickDraw 3D, and graphics hardware acceleration and, like the PC version, will use the new Window RAM memory. Power says that a 2-MB version of the card will cost "under $500."

The fact that these companies are entering the Mac market at the same time as the debut of Apple's PCI Macs is no coincidence. Vendors say they were already preparing PCI cards for the PC market, and adapting their cards for PCI Macs requires much fewer resources than redesigning for an entirely different bus, such as NuBus. "People are looking at the Mac market to make a little more money," Matrox's Power says. "Doing it without PCI would have required a total redesign." With PCI, the modifications required to bring a card over to the Mac, such as writing a new BIOS, are minor, vendors say. Other companies, including ATI Technologies and Diamond, also plan on introducing new add-in cards for the Mac.

Also, sources say that IBM was expected to introduce in late May a number of high-end PowerPC-based desktops for the business market, using a mixture of PowerPC 601 and 604 chips running at 100 MHz or higher. Because OS/2 for PowerPC is not expected to ship until later this year, the systems will ship sometime this summer with PowerPC versions of AIX and, perhaps, Windows NT.

POWERPC THINKPADS ARE COMING

In addition to PowerPC desktop systems, IBM was expected to announce in May two PowerPC-based notebooks, both of which will be based on the PowerPC 603E chip running at 100 MHz. The systems, which will look like current ThinkPads, will include a CD-ROM, 16 MB of RAM, a TFT (thin-film transistor) screen, and support for business audio. One version will offer a built-in camera for videoconferencing.

But IBM is stymied by the delay of OS/2 for PowerPC, and it's not certain when Microsoft will release Windows NT 3.51, which will support Alpha, Intel, Mips, and, now, PowerPC processors. In early April, Microsoft told vendors the OS would ship in "four to six weeks," says Mark Landrum, project manager for the new PowerPlay line, a series of PowerPC 604–based 100-MHz systems that IPC (Austin, TX) expected to release in May. IPC, which had previously sold only PC clones, says its new PowerPlay systems will target CAD, graphics, as well as other high-end applications.

However, vendors entering the NT PowerPC market must contend with a lack of native NT applications, which can't ship until NT 3.51 ships. "Windows NT 3.51 is on track for Q2 release," says Megan Bliss, lead product manager for Windows NT workstations at Microsoft. "I don't want to try to predict beyond that."

—Dave Andrews



Clear-Cut Answers

Your choice of a portable PC may not seem like a crystal clear decision at first. There are about a gazillion to choose from. Want some clear-cut answers to what's right for you? Gateway 2000® offers quality portables with performance and features that'll thrill you to chills. But whether or not a Gateway Liberty™ or ColorBook²™ portable PC is the right choice for you, look at these guidelines before choosing your portable PC.

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You'll need a 486DX2 processor at the very minimum. We strongly recommend a DX4. Spreadsheets, graphics and word processing all run better and faster with a DX4. All Gateway 2000 portable PCs include a DX2 or DX4 processor.

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RAM (Random Access Memory)

A bare *minimum* of 8MB RAM is best — 4MB wasn't enough last year. To run Windows (*and* Windows 95) you'll need 8MB. RAM will also increase your battery life and improve system performance. All Liberty and ColorBook² systems come standard with 8MB RAM and are expandable to 20MB or 24MB RAM.

Size and Weight

It's a portable PC — the smaller and the less it weighs, the better! The Liberty and ColorBook² emerge favorably in both areas.

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When you're talking portables, you want the biggest, clearest display possible without adding weight or hiking up the price.

A good way to judge screens is to divide the screen size of the portable by its weight. The Liberty has an incomparable screen size-to-weight ratio of 2.44. This 10.4-inch screen also gives you 23 percent more active viewing area than a 9.4-inch screen and 53 percent more than an 8.4-inch screen. The Liberty's 10.4-inch and ColorBook²'s 10.3-inch screens also give you the best value available in a color display.

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Look for between three and four hours of battery life depending on the processor and RAM. Batteries based on nickel metal-hydride (NiMH) or lithium ion will give you the best performance. The Liberty gives you up to four hours or more with power management. And it also allows for upgrading to a lithium ion battery.

Software

The better the included software applications, the more the value of your portable PC increases. Pre-installed on all Gateway portables is Microsoft Works for Windows 3.0 or MS Office Professional 4.3. The OAG® FlightDisk® and World Clock software is also included on all Gateway portables.

Keyboard & Pointing Device

You'll need a keyboard that's comfortable for you and that's also easy to use. The Liberty is equipped with a large palm rest, and flip-out feet so you can adjust the keyboard angle. Pointing devices vary greatly. Again, find one that's easy for you to work with. Gateway's EZ Point™ integrated pointer is positioned to be comfortable and easily accessible.

Infrared Technology (IR)

Extras such as the Liberty's IR technology add even more value to your portable PC. With it you can take advantage of wireless file transfer — this means transferring files between the Liberty and your desktop (or between two Liberty PCs) without cables!

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COLOR PRINTING

Color Encroaches on the Desktop

Technological advances should accelerate the use of color output in both the home and the office over the next several years. An impressive new color printer from Tektronix (Wilsonville, OR, (800) 835-6100; fax (503) 682-7450), the solid-ink Phaser 340, successfully addresses many of the problems associated with color printers: color print speed, color quality, plain-paper output, and maintenance. Meanwhile, analysts predict the sales of new color ink-jet printers priced at under $1000 should more than double in the next three years (see the accompanying chart).

The Phaser 340 ($4995) prints either black-and-white or color documents at approximately 4 pages per minute (compared to 2 to 3½ ppm for color lasers and about 1 ppm for color ink-jets generating four-color output). It prints on almost any type of paper or transparency film, and Tektronix has increased the 340's resolution to 600 by 300 dpi.

The Phaser 340's performance is due to a combination of Tektronix's solid-ink technology and a new internal print mechanism. Color is applied to a high-speed, rotating metal drum. The drum-rotation speed is then reduced, and color is applied to the paper. The result is vibrant color at high speeds.

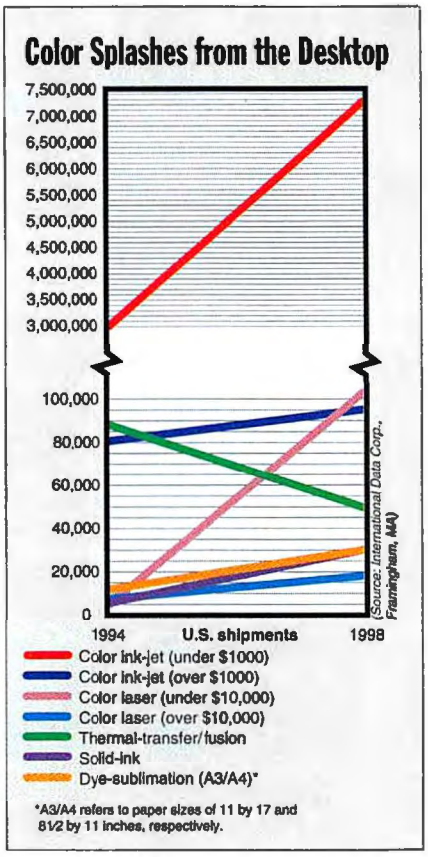
Unlike printers such as Hewlett-Packard's Color LaserJet, which makes you maintain separate developer and toner cartridges, you only need to refill the Phaser 340's four solid-ink slots.

Users who print mostly text with occasional spot color may prefer to go with a color laser printer, such as Tektronix's Phaser 540, which offers a rated speed of up to 14 ppm for black-and-white text. However, analysts believe the Phaser 340 is a strong new contender. "I think it's a viable color laser alternative," says Michael Weiss, president of MWA Consulting (Palo Alto, CA), a printing and imaging consultancy.

Vendors are also preparing a new round of ink-jet printers. HP (Santa Clara, CA, (800) 752-0900; fax (800) 333-1917) will likely introduce in June its new DeskJet 660C, an under-$500 color printer with print speeds of up to 1.5 ppm in color and 4 ppm in black and white. Also, Canon (Costa Mesa, CA, (800) 848-4123) was scheduled to release in late April the BJC-70, an under-3-pound printer with capabilities similar to those of its BJC-4000, for a street price estimated at $349. In addition, Lexmark (Lexington, KY) says it will release a slew of new color ink-jets this year. And Epson's (Torrance, CA, (800) 289-3776; fax (310) 782-4212) new Stylus Pro XL color ink-jet will offer better flesh-tone and color-transition printing than the current Stylus. It will also print on up to an 11- by 17-inch area.

"People are very conscious of color," says Charles LeCompte, editor of the *Hard Copy Observer* (Newton Highlands, MA). "In perhaps three years, more people will have access to color printing than [those who] don't."

—Jon Pepper



IDC predicts that, in terms of units shipped, color ink-jet printers will become the most popular color solution for the desktop.

INTERNET ACCESS

Service Providers Consolidate

The days of numerous tiny ISPs (Internet service providers) may be ending. Many midsize cities have four or more regional Internet providers, in addition to BBSes that offer Internet services. But observers predict there will soon be a consolidation of these providers.

The first steps toward Internet-provider consolidation have already been made in the U.S. On the national level, for example, on-line service CompuServe (Columbus, OH) recently purchased popular Internet software and service provider Spry (Seattle, WA).

Jeremy Allaire, president of New World Media (Minneapolis, MN), an on-line systems and Internet analysis group, says this buy-out is consistent with the revenue-generating models of major on-line services. With the acquisition of Spry, CompuServe will provide full Internet World Wide Web–based access through its network. "CompuServe bought Spry to acquire the software that they give away for free, but the model remains the same," Allaire says. "They make money [by] selling the user a data line."

Meanwhile, long-distance providers and the regional Bell companies are moving into the Internet market. MCI, for instance, recently rolled out its InternetMCI service. Pacific Bell has announced that, in partnership with CompuServe, Intel, Microsoft, and 3Com, it will offer combined ISDN and Internet services. "I think we'll see the vast majority of users accessing the Net through a small set of providers, in the range of 20," Allaire says. The remainder, he adds, will likely survive by providing expertise and infrastructure to local media companies (i.e., TV or radio stations) or businesses that want to set up Web pages.

—Steven J. Vaughan-Nichols
(sjvn@access.digex.net)

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PC Magazine



Watcom C/C++ simplifies and accelerates development of high-performance, multi-platform 16- and 32-bit applications. Watcom C/C++ delivers productivity and performance, combining our state-of-the-art compiler technology with an integrated development environment (IDE) and comprehensive set of tools.

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PC MAGAZINE EDITORS' CHOICE
April 11, 1995
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PC CONNECTIVITY

Vendors Ride Bus to Better Telephony

A new USB (universal serial bus) that supports a maximum of 12 Mbps could become a standard PC connector next year and eventually eliminate the mess of cables found behind today's PCs.

Like other serial-bus standards, such as Access.bus, Apple's GeoPort, and P1394 (also called FireWire), USB allows you to connect multiple devices through a single connection to a PC. But USB's maximum 12 Mbps makes it better suited for CTI (computer telephony integration) applications than Access.bus, which tops out at 100 Kbps. USB will cost less to implement than P1394, and it's backed by Compaq, Digital Equipment, IBM PC Co., Intel, Microsoft, NEC, Northern Telecom, and likely other companies in the future.

Serial Buses Compared

STANDARD	PEAK BANDWIDTH
Access.bus	100 Kbps
GeoPort	2 Mbps*
P1394	100–400 Mbps
USB	12 Mbps

*Mac serial communications controller implementation.

The most important aspect of USB is its ability to handle multiple isochronous data streams, which means multiple devices can operate concurrently with guaranteed throughput and data latency. Asynchronous operation is possible for devices that don't require guaranteed bandwidth. USB also permits the hot-plugging of multiple devices, such as modems, telephone switches, CD-ROM drives, multimedia audio devices, and tape backup systems, through a single four-wire connector. The interface supports up to 64 devices (one being the host computer itself).

Automatic-configuration software built into Windows 95 (though not necessarily the first release of Windows 95) will provide Plug and Play functionality for these external devices, allowing slotless, low-profile system designs that can be customized by unsophisticated users. USB's promoters say that laptop computers with USB connectors will easily connect through one port to a future generation of standard desktop peripherals without requiring a docking station.

Compaq, DEC, and IBM say they will support USB in future PCs, and NEC and Northern Telecom plan to build USB support into their future telephone devices. USB backers say the first PCs with built-in USB connectors should appear in early 1996. USB support has been promised for, in addition to Windows 95, Windows NT and IBM's OS/2 Warp.

One advantage that USB has over competing standards is its price. Jim Pappas, USB program manager at Intel (Hillsborough, OR), says future PCI (Peripheral Component Interconnect) chip sets from the company will support USB at no additional cost over that of current chip sets. (Texas Instruments currently sells its P1394 physical-layer and logical-layer chips for a combined price of approximately $30 each in 1000-unit quantities.) Intel will also make USB chips for peripheral manufacturers. Pappas predicts that USB connectors, which will be made by other companies, will cost system manufacturers a mere 35 cents per PC.

Intel officials say USB will likely coexist with other PC peripherals, such as current keyboards, mice, and serial and parallel ports, but they predict that USB will eventually replace all those ports and their associated wires. "We're quite confident we'll have USB on every computer," Pappas says. "And the way you make something universal is to put it on the motherboard." —**Matt Trask**

PROCESSOR UPGRADES

Pentium OverDrive = Moderate Upgrade

Intel's Pentium OverDrive processor is a compromise design. It puts a rocket in your socket, all right, but the upgrade socket has a 32-bit, 486-style I/O bus—not the faster, wider, 64-bit bus of a regular Pentium. The resulting bottleneck keeps the Pentium OverDrive from delivering as much performance as you might expect (see the accompanying BYTE benchmark table).

Still, it's faster than a 486, and Intel did a few things to compensate for the narrower bus. For instance, the Pentium OverDrive has twice as much primary cache as a regular Pentium (32 KB versus 16 KB), optimized cache lines, and a 5-to-2 core-to-bus clock-speed ratio that runs the CPU at 83 MHz in a 33-MHz system or at 63 MHz in a 25-MHz system.

To keep the OverDrive cool—it runs much hotter than a 486—Intel strapped a high-reliability fan on the chip. A small TSR program monitors the fan's rpm rate; if the fan slows down or stops, an error message pops up on the screen, and the CPU throttles back its clock speed to prevent a meltdown.

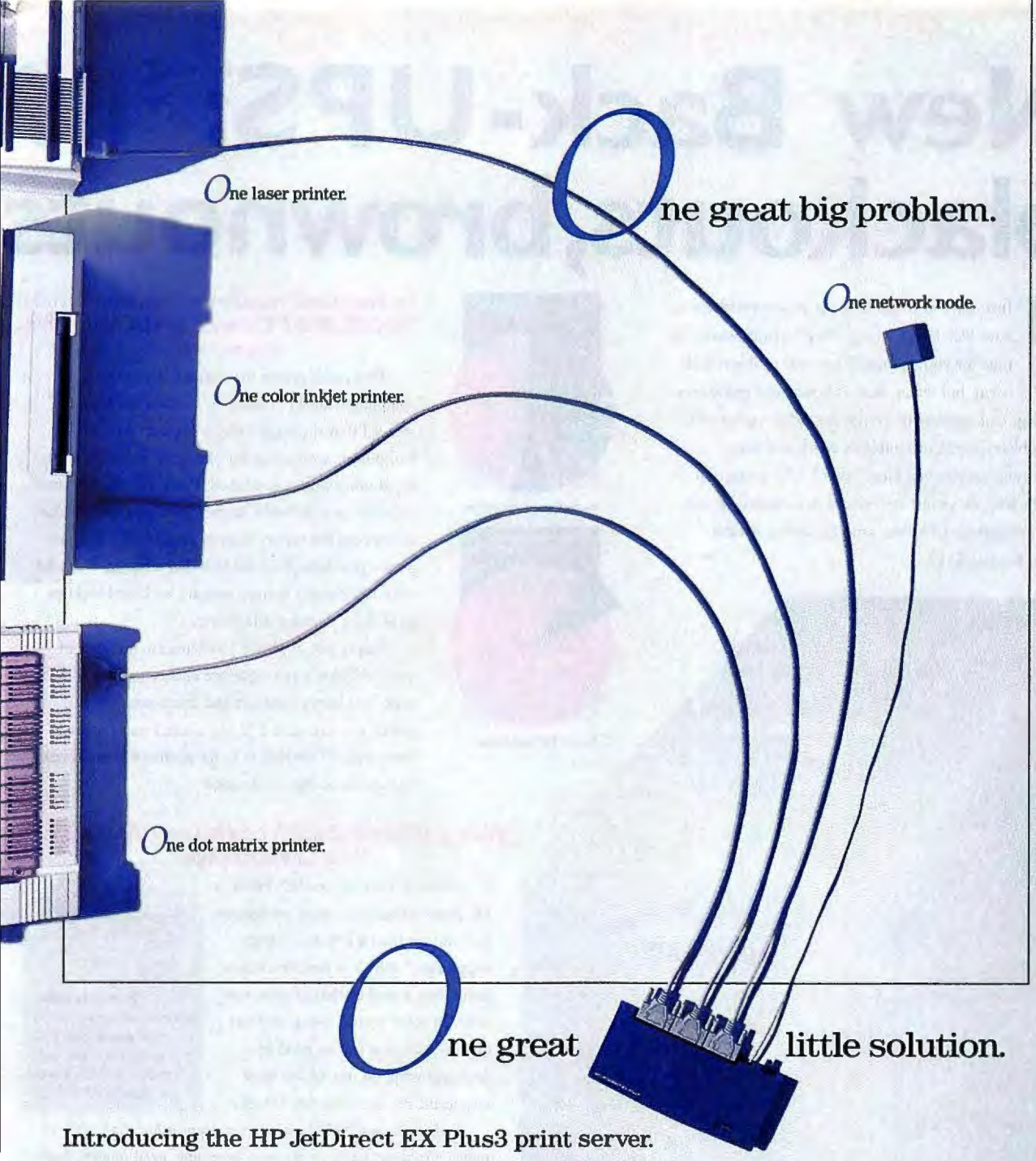
With a street sticker price of about $400, the Pentium OverDrive is a reasonable upgrade if your 486 system is otherwise adequate. You will also spend less time upgrading your office if you've kept good records about whose 486 systems are Pentium-upgradable—and which ones are not. But with prices of full-fledged Pentium systems plunging, you might be better off saving your money for a whole new computer. —**T. R. H.**

Pentium OverDrive Yields Modest Gains

The DOS version of BYTE's Native Mode benchmarks shows the performance of a 25-MHz 486 Zeos Pantera upgraded with a Pentium OverDrive chip to be less than that of a 90-MHz Pentium. The Pantera system we tested had a write-back cache. Intel estimates that 486 systems with write-back caches perform about 15 percent faster than similar systems with write-through caches after they have been upgraded. Many older 486 systems have write-through caches, but Intel says that by the end of this year, most 486 systems will ship with write-back caches.

	ZEOS 25-MHZ 486 PANTERA	PANTERA WITH PENTIUM OVERDRIVE
Integer index	.216	.704
FPU index	.135	.618

A 90-MHz Dell Pentium = 1.



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READERS' CHOICE

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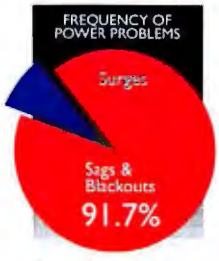
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Source: Contingency Planning

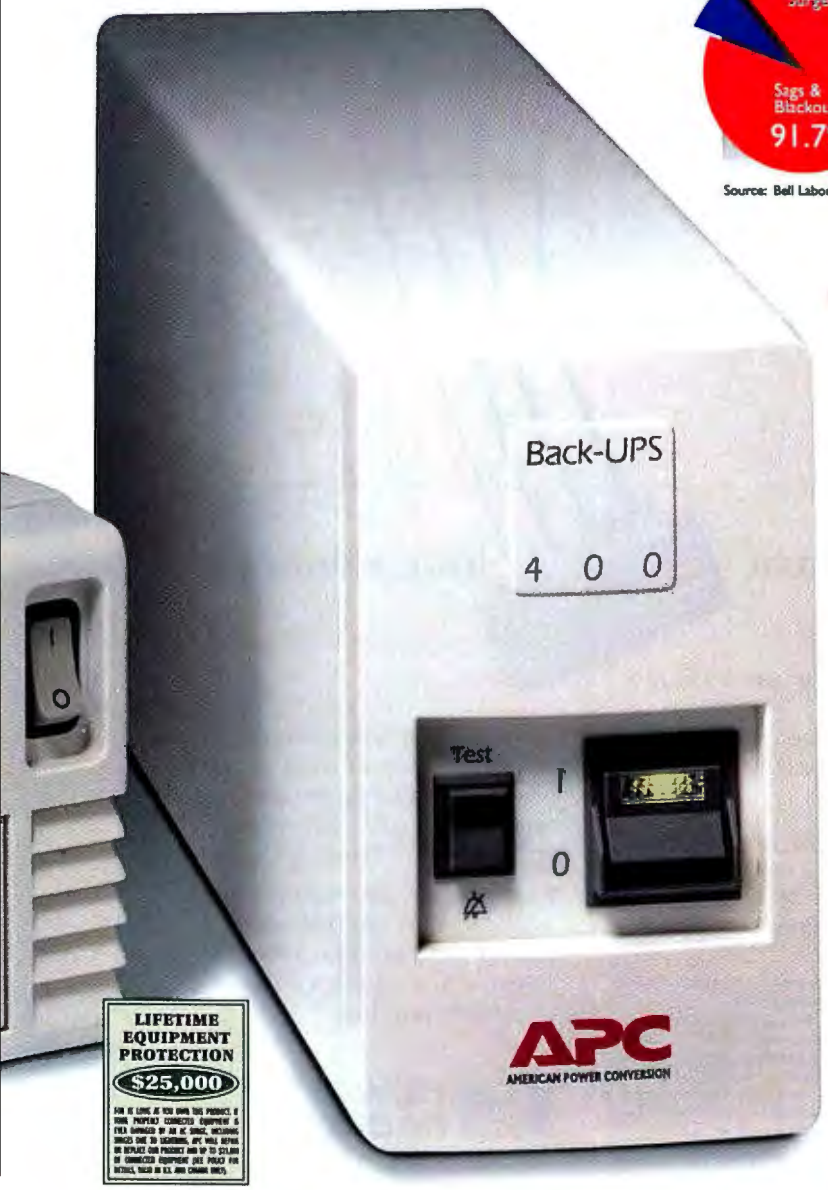


Source: Bell Laboratories

IN THE NEXT THREE MONTHS, MORE THAN 30,000,000 PCs WILL BE HIT BY POWER PROBLEMS...

Who needs power protection? If you use a computer, you do. A study in a recent *PCWeek* showed that the largest single cause of data loss is bad power, accounting for almost as much data loss as all other causes combined. Every PC plugged into an outlet is vulnerable. In fact, you have better odds of winning the lottery than of escaping the sting of power problems. One study found a typical PC is hit over 100 times a month, causing keyboard lockups, hard drive damage, and worse.

Simply put, if power problems are the least of your troubles, you've got one chance to keep it that way. You insure your car and home with the best policy you can afford. It just doesn't make sense to leave your PC (which is at far greater statistical risk) vulnerable to loss or damage.



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Contrary to most people's belief, a PC alone already has more protection built into it than a low-end "surge suppressor," which is usually nothing more than a well-packaged extension cord. In other words, going without any protection is just as good as underspending on one of the most important PC decisions you'll make.



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PC Magazine UK

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protection against and other trials by fire

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Trial by Fire

Brian Krause, Network Manager for Goodyear Airship Operations, knows how critical APC protection can be." The night of the All-star game a tornado came through our blimp hanger and took out our roof. Our airships demand absolute communication so I protect our local and remote servers with the most reliable protection I can find: APC. APC's PowerChute software shut our server down in an orderly way... closed out all files nice and neatly. When we reconnected, everything came back up perfectly, without a hitch."



Trial by Air

Doug Welch learns his reliability lessons well: "While still a Computer Science student, I was at home preparing a large spreadsheet for a final project when Anchorage experienced an all too common 5+ Richter earthquake. If not for my Back-UPS 400 it would have been back to square one! I'm now the Network Systems Manager at Charter College, in charge of three networks. I learned my UPS lesson well back in my student days. I've never been disappointed with APC and the product has had quite a work out."



Trial by Earth

Faced with a water main break, Mark Conley, Regional Manager of Novell's remote sales office in Detroit was amazed at APC's reliability. "The APC unit was sitting in an inch and a half of water, working just fine, as though nothing was unusual and we lost no data to this disaster. We've used APC here now for at least four years - more than a dozen units are all around the office, and we're well satisfied, so we were even more impressed to learn that the units are amphibious!"



Trial by Water



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900	Longer runtime	$529
1250	Multiple systems	$689

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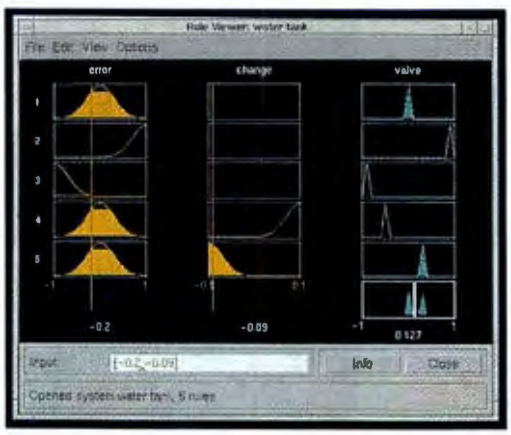
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PROGRAMMING

Getting Clear About Fuzzy



The MathWorks' (Natick, MA, (508) 653-1415; fax (508) 653-2997) Fuzzy Logic Toolkit ($895, available for Macs, Windows, and Unix) combines fuzzy-logic modeling with engineering-design tools that integrate with the company's Matlab technical-computing environment and Simulink graphical simulation environment.

What do pension plans, elevators, and battery chargers all have in common? Each is an important application of fuzzy logic, a style of computing that is slowly and, according to experts, inevitably replacing the binary-based processing now found in many of the world's applications.

"Any application that's logic-based can be fuzzy-based," says David Brubaker, a fuzzy-logic consultant for Huntington Advanced Technology (Menlo Park, CA). "There's more fuzzy logic around than you probably think, from your appliances at home, to the car you drive to work, to the heating system in your building," he says. However, Brubaker adds that many fuzzy-logic designers won't discuss their projects, "either because they don't want to give away any competitive advantage or they are afraid of losing sales if their customers found out."

Such fuzziness about fuzzy logic has stifled the market, according to Bonnie Packert, cofounder and executive vice president of HyperLogic (Escondido, CA), maker of CubiCalc, one of the first general-purpose fuzzy-logic-design tools. Like many companies in the business, HyperLogic has experienced slow growth. "I think part of the reason is a lack of exposure for fuzzy, especially in the press," Packert says.

However, Market Intelligence Research (Mountain View, CA) says that worldwide fuzzy-logic revenues were $2 billion in 1994, a number that will reach $8 billion by 1998. The research firm also says that U.S. and European companies are now taking an active interest in the field, following successful commercial fuzzy projects in Japan.

Fuzzy logic provides a way for computers to deal with the ambiguities of the real world. Rather than using numbers that are always true or not, fuzzy applications can use numbers that are very true, slightly true, or somewhere in between.

FuziWare (Knoxville, TN, (800) 472-6183 or (615) 588-4144; fax (615) 588-9487) holds a patent on using fuzzy mathematics in a spreadsheet. With the company's FuziCalc product, which can import data from Windows-based spreadsheets, you can create scientific, technical, and financial-projection models that use fuzzy logic.

A simple example of an application of fuzzy arithmetic is revenue forecasting, in which you take historical data, such as a previous year's revenue, and project it for future years using three likely growth rates to derive a triangular fuzzy number. You then project revenue by multiplying the base revenue by (1 + the fuzzy growth rate). "Knowing the relative degree of belief across the range is critical information," says Karl Thorndike, president of FuziWare. "Encapsulating that information into a single fuzzy number keeps you from throwing away information each time you do a calculation."

—Randy Cronk

An Early Survey of Windows 95 Plans

It's starting to look like Microsoft will release Windows 95 this August. BYTE recently polled a number of vendors to gauge their Windows 95 applications plans. The following list is not a comprehensive list of functionality; all the vendors we surveyed were still developing applications, and their feature sets were not all finalized at press time. All vendors will support some element of OLE 2.0, as well as long filenames.

Corel ((613) 728-8200; fax (613) 728-9790)
CorelDraw 6. Offers faster redrawing, multitasking, and multithreading; OLE 2.0 automation; and in-place editing. Has a new presentation module that offers 3-D modeling. Also, CorelCAD, a 3-D CAD package for Windows 95, and 32-bit Corel Ventura 6, which offers support for HTML (Hypertext Markup Language) and SGML (Standard Generalized Markup Language).

Delrina ((800) 268-6082; fax (408) 363-2340)
Rebuilt 32-bit versions of WinFax Pro and WinComm Suite. Both offer background communications without the hiccups. They now support call control through TAPI (telephony API), and unified messaging lets you store fax, E-mail, and voice messages in one mailbox.

Lotus Development ((800) 343-5414 or (617) 577-8500)
Windows 95 version of SmartSuite. Includes OLE 2.0 and information-sharing among applications, including Notes. Team-collaboration tools in 1-2-3 and WordPro (formerly Ami Pro) let you distribute portions of a spreadsheet or document to colleagues via a LAN, Notes, or E-mail; collect comments and annotations; and consolidate them in your final document.

Micrografx ((800) 765-7859 or (214) 234-1769; fax (214) 994-6477)
Picture Publisher for Windows 95. Offers extensive support for multithreading; is 50 percent faster when working with large files and 200 percent faster when applying filters.

Microsoft ((206) 882-8080)
Windows 95 32-bit versions of Excel, Schedule Plus, Word, and other applications. Single-threaded assembly code for Excel recalculation has been hand-tuned for 32 bits, making it 50 percent faster than before.

Stylus Innovation ((617) 621-9545; fax (617) 621-7862)
Visual Voice 32-bit OLE controls, which are environments for developing computer-telephony applications, such as interactive voice response, text-to-speech, faxback, or voice recognition. These OLE controls can be used in any development environment that supports OLE, such as Access, Delphi, Excel, PowerBuilder, and Visual Basic 4.0.

3D/Eye ((800) 764-5237; fax (607) 257-7335)
TriSpectives 1.0, an affordable 3-D product-design and graphics tool for professionals, combines a CAD engine with a GUI.

WordPerfect
PerfectOffice for Windows 95 (which includes WordPerfect for Windows, Quattro Pro, Presentations, InfoCentral, Envoy, and GroupWise) will offer full OLE 2.0 support and up to a 60 percent performance improvement in some areas due to 32-bit code, code tuning, and more shared code (and, thus, less hard disk access). Other benefits: Long filenames are supported at the OS level, and OLE drag-and-drop support will break down existing walls among applications.



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ADAPTIVE COMPUTING

Windows 95 Sees Better Future

Windows has been a mixed blessing for disabled computer users. People who are unable to type on a standard keyboard can benefit from Windows and other GUIs like the Macintosh interface, in which a few keystrokes or mouse-clicks can accomplish many tasks. But for blind or moderately visually impaired users, using Windows with adaptive equipment, such as speech, braille, and screen-magnification systems, can be frustrating. And, due to inconsistent programming methods by Windows software developers and a lack of standards, adaptive equipment that verbalizes important information, such as the current position of the mouse cursor, doesn't always work. Microsoft now says it will work to improve Windows' support for blind users.

One near-term solution in which Microsoft hopes to improve Windows' accessibility is by putting its Access Pack of utilities, which aids disabled users, in the Windows 95 control panel. The Access Pack can provide such assistance as holding and locking the Shift keys, allowing mouse movements via the arrow keys or an external adapted switch, and making the screen flash when the speaker beeps. These utilities make a computer more accessible for users with hearing or other physical disabilities.

The company also plans to improve Windows' support for third-party assistive devices. "We plan to provide extra assistance to independent software developers writing accessibility software, give the developers increased access to low-level technical information, and evangelize how to make programs more accessible across the board," says Greg Lowney, a senior program manager in Microsoft's Accessibility and Disabilities Group.

Microsoft also plans to implement new features in its API and DLL library to make Windows 95 more compatible with adaptive hardware and software. A Helper.DLL file, which will be released shortly after Windows 95, will expose system information (e.g., the on-screen location of a menu item) to accessibility products through a supported, documented interface. Further out, Microsoft has other plans. "Our intention is to use the off-screen model [OSM] as the basis of a component architecture to provide access to information on the Windows screen," explains Lowney. In the OSM, a database tracks the data that a Windows application writes to and removes from the computer's screen. A screen-reader program queries the OSM to find out exactly what's on the screen at any given time so that it can reliably report this information to a blind user.

People in the disabled community welcome Microsoft's plans but remain wary. "I am impressed with what Microsoft has agreed to do and to consider," says Paul Schroeder, national program associate for technology and telecommunications at the American Foundation for the Blind (Chicago, IL). "But we must remain vigilant to ensure that they and other companies really commit to making computers more accessible for persons with disabilities." —Joe Lazzaro

CODE TALK

RICK GREHAN



ANSI C Anywhere

Some time ago, a fellow BYTE editor loaned me his notes and documents from a conference on how to retarget GCC, the GNU C++ compiler. After spending days poring over the materials, I emerged none the wiser, and simply more jealous of anyone who'd succeeded in building his or her own GCC compiler. Apparently, I didn't have the mental stamina required to accomplish this task.

Then I found out about the Retargetable Software Tools from Archelon (Waterloo, Ontario, Canada, (800) 387-5670). I'll say right up front that Archelon's tools build C compilers, not C++ compilers. Furthermore, the software is not cheap: The starting price is $3495. But you get a set of tools to construct a C compiler, an assembler, a linker, and a librarian for whatever target processor you wish (provided, of course, that the processor is powerful enough). There's also a preprocessor for the compiler's front end and a peephole optimizer for its back end.

Furthermore, the C compiler is ANSI compatible. Archelon's president, R. Preston Gurd, informed me that the company has verified the output with the Plum-Hall suite.

I spent most of my time with the kit working with the C compiler portion. That meant wading through the CIF (compiler information file). The CIF tells the compiler everything it needs to know about the architecture of the target machine, including available registers, which ones can be used for indexing, which one can be used for the stack pointer, whether there's a frame-pointer register, the format of assembly instructions, and addressing modes.

Using these tools, you end up working in two directions at once. On one end is the target processor's architecture. On the other end are the rudimentary operators that the compiler understands. Your job is to connect the two.

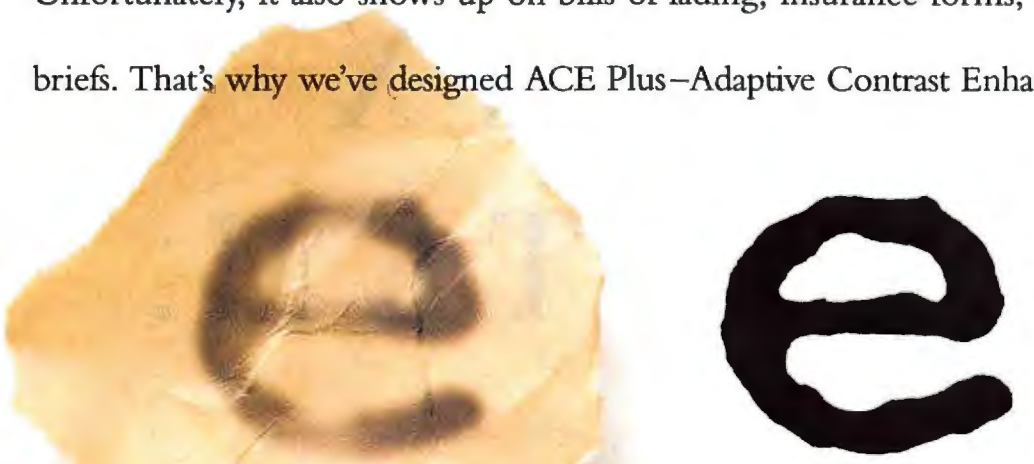
For example, one of the compiler's fundamental operators is SUB; its format is "$dest = $left – $right," which means that the SUB operator subtracts the right operand from the left operand and puts the result in a destination operand. Your job is to teach the compiler the assembly instructions it must emit to perform a SUB operation. Of course, a SUB operation can have characters, integers, long integers, or floating-point values as operands; you have to take all cases into account.

I won't kid you; this stuff is not for the squeamish. I recommend that you work through the demonstration files, trying a little reverse-engineering until you get the feel of how the commands in the CIF work. Then bring up your compiler piecemeal—don't try to do the whole thing at once. You can have it output dummy instructions for the operators you're not sure of in the beginning and then complete it all later.

My biggest complaint is that the documentation could stand more work. I appreciated all the Backus-Naur diagrams—they helped me figure out the proper syntax for a command—but more examples, such as a tutorial for an 8088 C compiler, would make the process smoother. Still, if you find yourself working with a variety of processors or custom microcontrollers and you'd like to start building a library of ANSI C compilers for yourself, Archelon's Retargetable Software Tools deserves a look. I worked with the DOS version; versions also exist for Unix System V release 4.2, HP-UX, SunOS, and Solaris 2.x.

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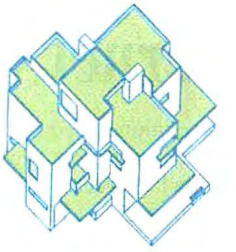
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INTERNET COMMERCE

Caching Could Stall Internet Commerce

A technique used by service providers to give their users fast access to World Wide Web pages could stymie the plans of companies who want to rent out electronic-store space on the Internet.

The problem is due to a technique called *caching*, in which Internet providers cache Web pages to provide fast access to popular ones. Web caching is already used by Internet systems using the CERN (European Laboratory for Particle Physics) Web server in proxy mode as part of firewall security systems. Caching moved to the front of Web publishers' concerns earlier this year when the Prodigy on-line service, based in White Plains, New York, released its Web browser and its caching Web-server software.

Because of its Web caching, Prodigy's 1-million-plus potential Web readers see a faster response time when they access a popular Web site. But since Prodigy's readers are accessing the Web cache instead of the actual Web itself, the reliability of the number of times that users access a specific page (known as *hits*) is reduced.

Prodigy's caching scheme is troubling to some Web publishers who rely on accurate page hits to determine the popularity of their Web pages (and, in some cases, to set Web-space advertising rates). "I rely on hit counts to determine whether or not I am posting data that people want to read," says Bob Wyman, vice president of new technologies for Medio Multimedia (Redmond, WA), publisher of a CD-ROM monthly magazine called *Medio Magazine*. "My business depends on accurate data about user preferences," he adds.

However, Don Tydeman, publisher of *NetGuide Magazine* (Manhasset, NY), says the use of Web hits is not useful for determining Web-page pricing models because it assumes that the electronic-publishing model is similar to the print model and that readers behave in comparable ways. "That's simply not the way it is," he says. Tydeman adds that the value of a Web page is in the quality of the relationship that exists between the marketer and the customer and the Web's ability to provide both with such benefits as shorter time to market, cost savings, and expert advice.

Other firms are now exploring alternatives to the Web-hit model. Tom Dubois, director of business strategy for Nielsen Media Research (Dunedin, FL), a major media-tracking company, says his firm is investigating several measurement methods, including hit audits, user surveys, and tracking certain Web users and the Web sites they access.

Ken Appleman, Prodigy program manager for the Internet, says that he's aware of the issues lurking behind Web caching, noting that Prodigy is also in the Web publishing business. "Today, you really can't use the number of hits you get for useful financial purposes," he says. "The World Wide Web Consortium [W3C] is aware of the problem, and Prodigy will work with the W3C to find a solution for it."

It's too early to predict what model (or models) Web publishers will use. However, Web publishers and marketers agree that a metric for measuring the value of Web services will be found. Business demands it.

—S. J. V.-N.

INTERNET INDEX

Estimated number of people who can use interactive services on the Internet: 13.5 million

Percentage of movie ads with Internet addresses in the *Boston Globe* on February 12, 1995: 8

Number per day of Prodigy users registering to use Prodigy's Web access: 15,000

Price per hour of Web access on Prodigy after the first 5 hours: $2.95

—Compiled by Win Treese (treese@openmarket.com)

Whatever Happened to ...

Hewlett-Packard's Kittyhawk?

(see "HP Delivers Matchbox-Size Hard Drive," July 1992 BYTE, page 32)

Hewlett-Packard's 1.3-inch Kittyhawk hard drive, which packed about 20 MB of disk storage into a rotating hard drive about the size of a matchbox, was a marvel of miniaturization. The drive's components were so small and precise that HP joined forces with Japanese watch company Citizen to manufacture the drive. But HP discontinued the line last year, citing lower-than-expected sales.

Eric Larson, HP's operations manager for mobile storage, says the company designed the Kittyhawk for use in mobile-computing devices, such as PDAs (personal digital assistants) and small hand-held devices, and nontraditional applications, such as game machines and printers. In 1993, HP tried to remedy one weakness of the Kittyhawk—its low capacity—by releasing a second implementation of the drive that doubled its capacity to 40 MB.

But Larson says the main factor in HP's decision to discontinue the line was weak sales in the subnotebook market. "The subnotebook market had trouble developing and is still in trouble today," he says. "Products didn't come out and were either canceled or delayed."

HP has manufactured the drive in small quantities since 1991 to satisfy its contracts with vendors, but it will end production this summer. According to Larson, HP is applying the knowledge it gained in manufacturing technology and automation during the Kittyhawk project to its factories in Penang, Malaysia, and Boise, Idaho. As far as getting back into the market with the Kittyhawk, Larson says, "We'll watch and see what happens." —Nick Baran

IBM's Workplace Shell for DOS?

(see "OS/2 Gets Lean and Mean," August 1994 BYTE)

Users who prefer a character-based PC OS will find much to investigate in IBM's new PC DOS 7, including a tape backup facility, a file-synchronization utility, the ability to create compressed drives of up to 2 GB, and many other new attributes. But one feature noticeably absent from this latest version of PC DOS from IBM's Personal Software Products Division (Austin, TX) is the version of the Workplace Shell that was to provide a graphical shell to support task switching, drag-and-drop operation, file management, and other functions for PCs running DOS in real mode. IBM officials say the shell for PC DOS is currently on hold and "may or may not be" ever released.

And what about a new version of MS-DOS? Microsoft officials say the company is currently focused on getting Windows 95 into the channel by August. After that's released, Microsoft will evaluate whether it should further develop MS-DOS. Meanwhile, Novell says that it will no longer release new versions of Novell DOS.

—D. A.

Blasts from the Past

DENNIS BARKER



Like Godzilla appearing on the edge of town, Windows 3.0 finally arrived. But people didn't run away. They ran out to buy it. Jon Udell, who'd worked with beta versions for months, rightly wrote that version 3.0 would change the face of DOS computing: "After years of twists and turns, Microsoft has finally nailed this product." His forecast: "The Windows momentum that has been building is about to become a tidal wave."

Father of computer graphics. We paid tribute to Ivan Sutherland. As a graduate student at MIT in the 1950s, he developed the SketchPad. You could use it to draw, rotate, and edit primitives, without having to be an ace programmer. Sutherland had created the first CAD program.

"Who Needs OS/2?" That's what we asked on our cover, but that wasn't really the issue. OS/2, which Microsoft still sold at that time, had things Windows didn't, such as a multithreaded architecture and a 32-bit progamming model. And it lacked something: a foundation built on "creaky old DOS." Power users, we said, "will find the move from Windows to OS/2 a natural."

Sun lowered the price/performance curve with its SparcStation SLC, a diskless workstation priced below $5000 (12 MIPS, 8 MB of RAM, Ethernet, and a 17-inch monitor). "Quite a bargain for an office running a network of SparcStations."



State of the Art scouted out coming networking technologies: wireless LANs, fiber optics, ATM (asynchronous transfer mode), and zapping data over AM and FM radio.



Trendsetting board of the month: VideoLogic's DVA-4000. By converting analog signals from a TV, VCR, or laserdisc player, the board let you play live video in a window on your VGA screen. We pretended stockbrokers would use it to snag Dow quotes or watch financial news shows.



Programming techniques. Hundreds of pages on languages, libraries, debugging techniques, subroutines, data-flow diagrams, and tricks for the 6502 programmer.

GEM '85 Our West Coast editor John Markoff reported on Digital Research's GEM (Graphics Environment Manager) after attending a seminar for OEMs and programmers thinking of converting to the new GUI. It appeared GEM's biggest competitor was the Mac OS. GUIs that were in the works for IBM-type machines—Desq, Visi On, and something called Windows—seemed to be jinxed.

ComponentWare '85 "Software-ICs" proposed a plan for building reusable software components. "The notion of *objects* that communicate by *messages* is... fundamental to Software-ICs."



The Mindset was a PC clone that did some graphics chores in hardware, and it was swift at running Time Arts' Lumena paint program. One model had genlock circuitry, so it could interact with video cameras and recorders (shades of the Amiga).



CyberBYTE We officially announced the BYTE Information Exchange, becoming the first magazine to extend into what is now called cyberspace. BIX featured on-line conferences, E-mail, BYTE articles, and the massive collective knowledge of BYTE readers.



On the cover, Robert Tinney "created a visual fantasy on a communications theme. Imagine a network of personal computers where each person's computer is a node." Editor Carl Helmers noted that this "fantasy" network already existed: the phone system combined with modem equipment.

Intercomputer communications was the focus of the issue. Helmers proposed "The Grass Roots Electronic Post Office"—basically a global E-mail system. "Thus any two people who have a personal computer and a Bell 103–compatible modem can send electronic messages back and forth."

And Flipper scores the winning touchdown. An article about AI-based personalized news services told this story: A Stanford researcher put in his profile that he would like to see any stories about dolphins. Sure enough, his report included football scores—of the Miami Dolphins.



In the News, June 1985

Lotus and Intel announced an expanded-memory specification for PCs.

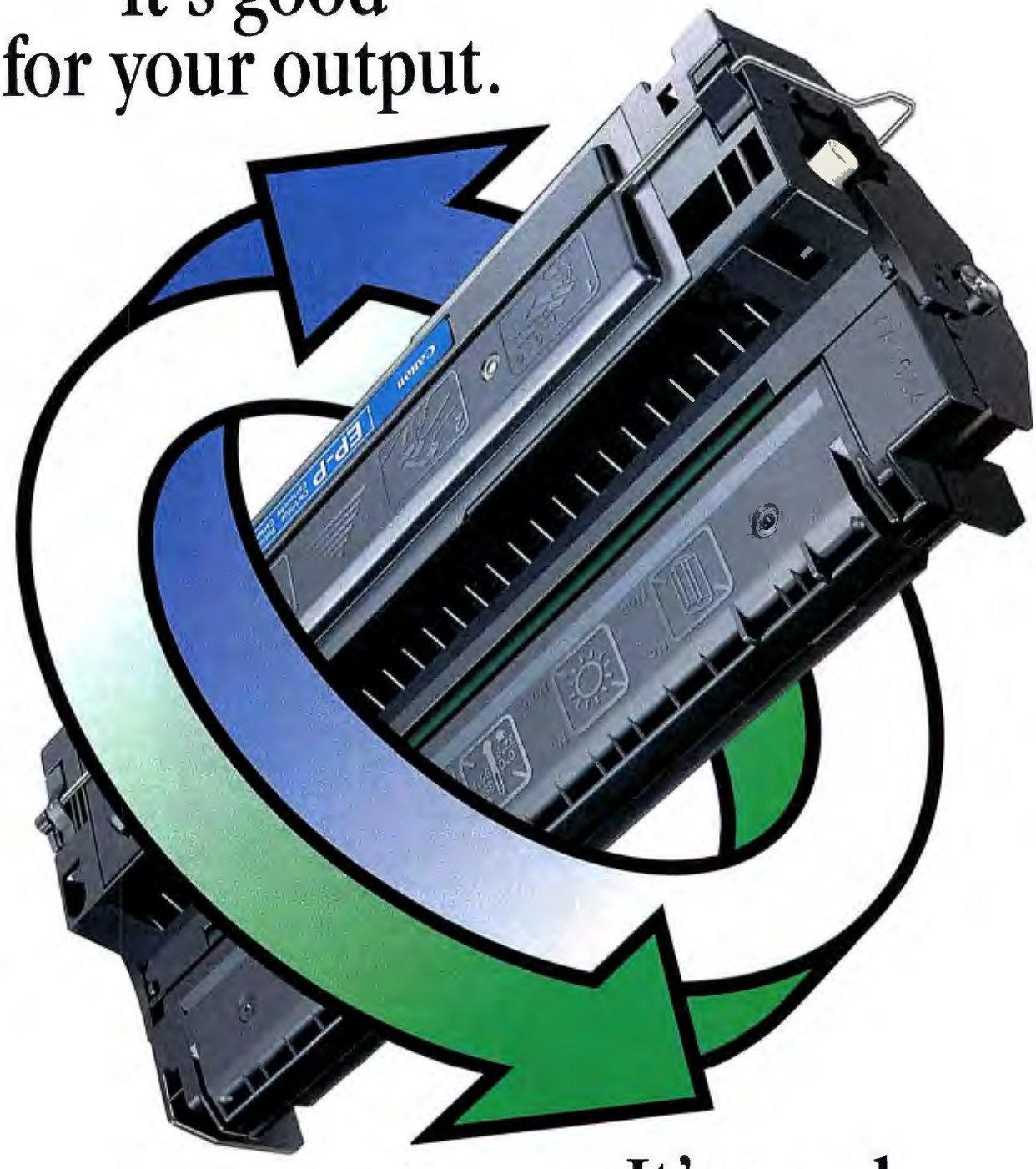
At Comdex, Compaq announced 286-based Portable and Deskpro models; TeleVideo unwrapped an AT clone that used an 8-MHz 286 (the IBM AT used a 6-MHz chip); Zenith brought out two "portables," weighing 17 and 25 pounds.

Manhattan Graphics released ReadySetGo, once of the first desktop publishing packages.

Microsoft introduced Access—a $250 communications program, not the database program.



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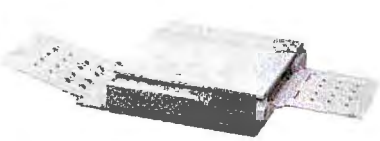


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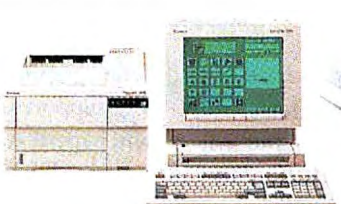
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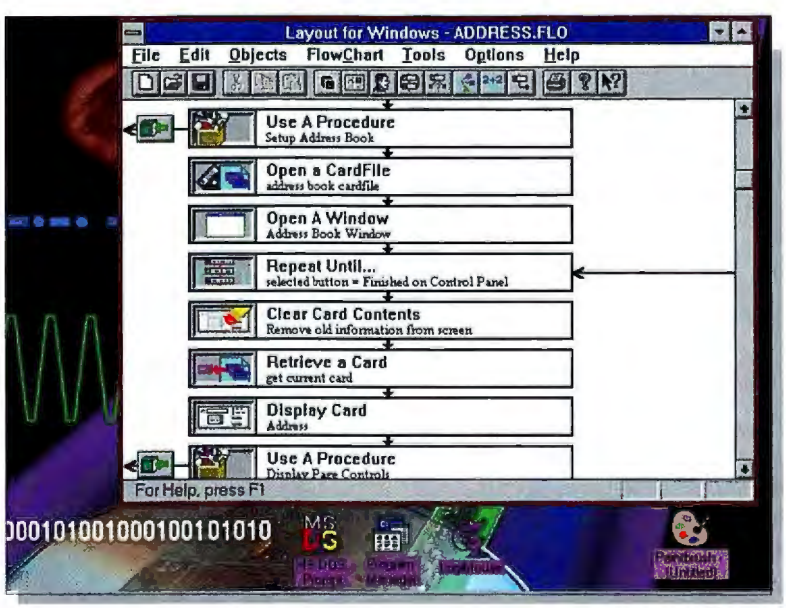
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Word Overload, Information Shortage

ANDY REINHARDT

Given last year's wave of best-selling books about the Internet, it's not surprising that publishers are cranking out even more titles concerning the information superhighway. The four books reviewed here offer varying degrees of insight about this most nebulous of topics. Unfortunately, they don't provide deep technical information on gnarly subjects, such as how video servers will accommodate 50,000 concurrent requests for the latest Spielberg movie or whether transaction systems will be able to handle 20 million Super Bowl viewers pressing "Buy" on their TV remotes simultaneously. Three of the titles are general-interest books. The fourth, *Realizing the Information Future*, is more of a policy paper.



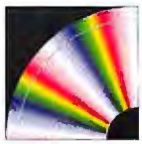
Of the three general-interest books, *Inside the Information Superhighway Revolution* by Nicholas Baran is the most informative and best written. In lively, readable prose, Baran provides a good overview of the whole topic, including key players, hardware and software, networking, and content. He also tackles some larger questions, such as privacy, cost, and equality of access. Baran does a good job of explaining in lay terms such concepts as analog and digital, bandwidth, and video-on-demand, and he goes deeper into the technology of the information superhighway than do his counterparts. But even so, expert readers will find the book fairly nontechnical.

For some reason, *Inside the Information Superhighway Revolution* does not say exactly what the information superhighway is, and it would benefit from additional graphics to illustrate the layout and architecture of various proposals. I wasn't crazy about the slightly hokey forward, which appeared to have been tacked on by Baran's editor to illustrate whiz-bang futuristic applications. And I found slightly disingenuous Baran's frequent references to "hype" and "buzzwords" about the information superhighway in a book largely uncritical of its subject. But overall, Baran's book is thoroughly researched and smoothly written.

At the other end of the spectrum is *Detour: The Truth About the Information Superhighway* by Michael Sullivan-Trainor, a senior editor for *Computerworld*. Though he is enthused about the subject and has done some research, the writing is unfocused and meandering. *Detour* is full of information, but it careens from one topic to another and often repeats itself.

Detour's biggest problem may be its title and cover, which misrepresent and overpromise. The title implies that the book is a hard-hitting debunking of infobahn hype, which it is not, and the

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cover lines suggest that it contains extensive interviews with assorted luminaries, which it does not.

The Information Superhighway: Beyond the Internet is by Peter Otte, an editor for *Mobile Office*. It was obviously written in a hurry. Though it has a nice, colloquial tone, it's so light that it borders on fluff. Otte takes the broadest view of the three authors, which is to say that he touches on everything from the Newton to home theater design, and from PCMCIA to schoolyard violence. At times, the text veers into silliness.

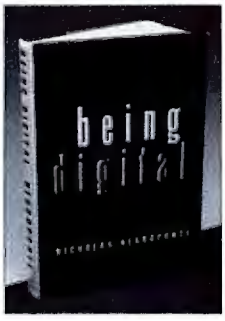
Realizing the Information Future: The Internet and Beyond is a report authored by a group of distinguished academics and businesspeople called the NRENaissance Committee, convened by the National Research Council in Washington, D.C. It is dry and academic, but it may be the most informative of the four.

The book outlines in great detail the technical issues of the information superhighway and provides a set of recommendations for an Open Data Network. It's a thoughtful, reasonable, and frankly inspiring prescription that leaves behind partisan politics, marketing glitz, and economic considerations. The information superhighway it sketches would be, if implemented, the most democratic, and it would most successfully avoid technical obsolescence.

Andy Reinhardt was formerly BYTE's West Coast bureau chief.

CONVERTING LIFE INTO BITS

BEING DIGITAL by Nicholas Negroponte
Alfred A. Knopf, ISBN 0-679-43919-6, $23



As founder and director of MIT's Media Laboratory, Nicholas Negroponte has had a front-row seat at the conversion of reality into bit streams. In *Being Digital*, he shares his experiences, insights, and predictions. It's a well-written and engaging book, and if you see the irony in the medium being a *book*, yes, so does Negroponte.

His analysis of such digital developments as the Internet, cable TV, "digital convergence," computer interfaces, E-mail, CD-ROM, and multimedia will appeal to experts and novices alike. The expert will see many familiar themes that have been playing out in reality, but they're juxtaposed and extended in new ways. Negroponte plays with ideas and insights like glass beads, stringing them together in ways that are suggestive, predictive, and creative. For the novice, I can imagine no more engaging tour guide of the digital technology of the early twenty-first century.

One of Negroponte's main messages is about the freedom of digital representations. This plays out in a number of phrases that pop up like slogans throughout the book. "Bits will be bits." "Information will win out." "Bits know no borders." In his view, there is a kind of Darwinian survival of the fittest, an inevitability to the current state and the future unfolding of technology.

Negroponte's predictions, woven throughout the book, may take five years or 50 years to realize, but there is little doubt that here is the shape—the outline, if not the detail—of the future. Anyone planning to live there should take a peek. ■

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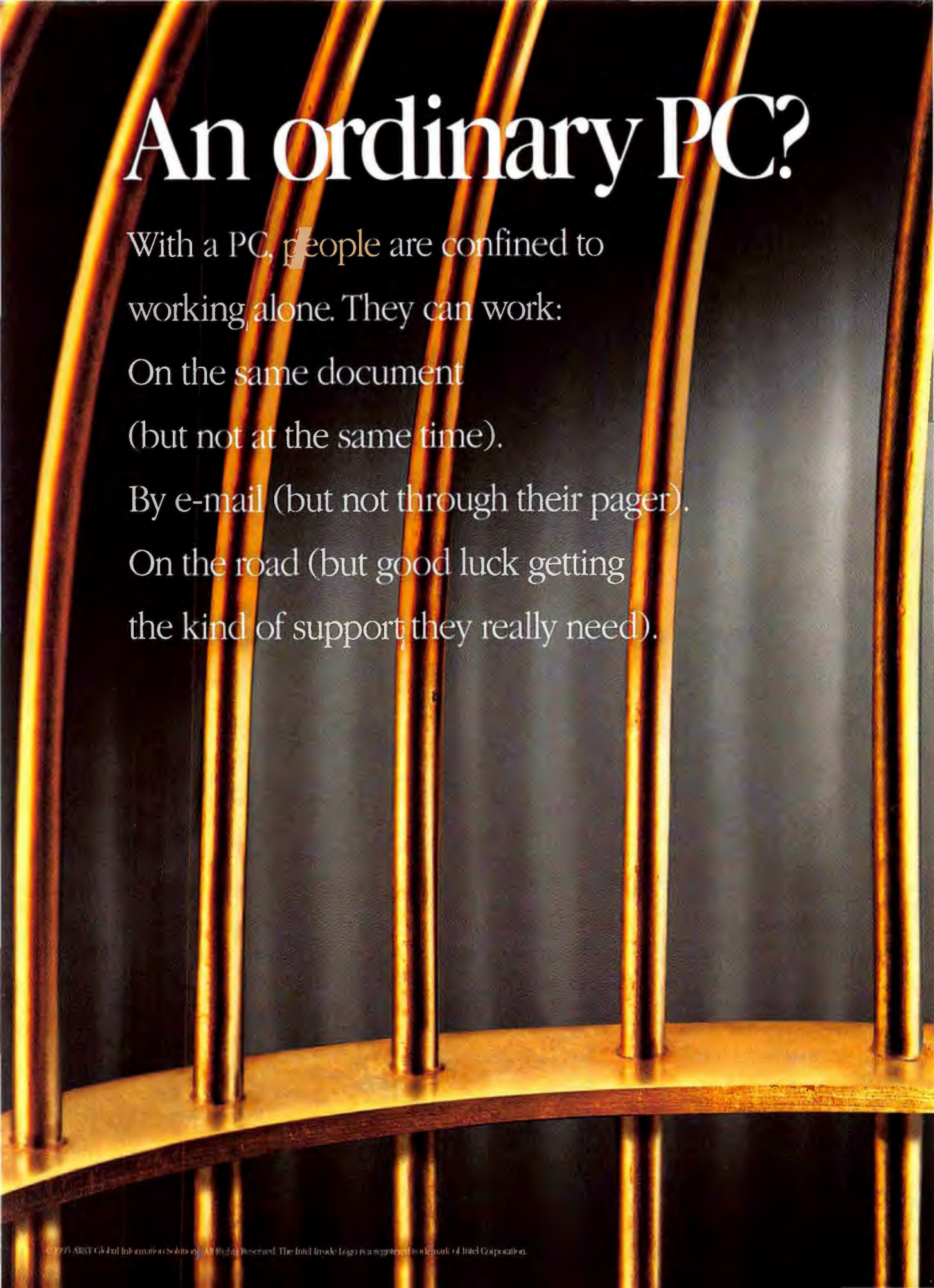
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Not Lost in Space

MICHAEL NADEAU

Last September, Xerox gave part of its New England sales force notebooks and kicked them out of the office. The 135 sales representatives, analysts, and managers in the northern customer operations division would never again have permanent space at the regional headquarters. Instead, each person has a virtual office consisting of a notebook, a modem, a LAN adapter, and Microsoft Office. Xerox won't stop with the Waltham, Massachusetts, office. Within a year, it expects that all 5500 members of its U.S. sales force will work from virtual offices.

Xerox had good reasons for its decision. Salespeople now spend more time in front of customers, and overhead costs have been slashed. But the real catalyst for the change was a legacy system from hell. Xerox's information infrastructure was based on mainframes, some over 20 years old. As the company added more applications and brought more departments on-line over the years, the system grew in piecemeal fashion with undesirable results.



Bill Pittman and Mike Radigan of Xerox

MARK KOZLOWSKI © 1995

Many new applications came with their own databases, so one application maintained price lists, another processed customer orders, and another tracked inventory. Linking those databases was difficult—if not impossible—even for those running on the same mainframe. Different geographic regions, particularly those overseas, had systems that could not talk to anyone else's.

The old setup, says Bill Pittman, Xerox's corporate vice president and business process manager, "did not allow us to be responsive to our customers. When we did respond, it was with a sneakernet approach." In some cases, he adds, 10 to 20 systems were used to get information requested by one customer.

Although Xerox is not the first company to implement the virtual-office concept, it did so in a remarkable way. Earlier pilot programs in other sales regions uncovered potential problems and pointed to innovative solutions. Those solutions, however, meant a complete overhaul of not only the legacy systems but also the regional facilities themselves. The pilot programs proved that salespeople did not need permanent offices, but it also showed that quick and easy access to information was essential for them to be effective on the road. The legacy system simply was not able to deliver that type of access.

Xerox closed a regional sales office and pushed the sales staff out on the road—where it belonged

A Tougher Sell

The company's products and services—including printers, copiers, on-demand printing systems, and network consulting—were becoming increasingly complex. Sales representatives had to spend more time working with clients to understand their needs. But, according to Pittman, they were also spending 30 percent of their time chasing information stored on the legacy system. Consequently, the sales force spent only 40 percent to 50 percent of its time in front of customers. For Xerox to reach all its potential customers, that percentage would have to increase.

"Solutions selling today is much more complex," says Cathy Lewis, a Xerox vice president and former district manager of sales for Xerox's New England North region. She estimates that her region alone has 2000 to 3000 potential customers. Her staff could not reach them all if they spent only half their time with customers. Rather than hire more people, says Lewis, Xerox wanted to get more out of the staff it already had.

The goal, according to Pittman, was to develop a full marketing and customer database. This database would provide marketplace information, customer profiles, order information, and solution libraries. In short, one centralized data repository would have everything needed by the sales force and other departments, such as manufacturing. Much of the work on this database, which was built using Oracle, has been done. Although it resides on mainframes in the form of a data warehouse, it appears unified to anyone accessing it.

Sales personnel can choose any communications package for general use, but to connect to the data warehouse, they use Wall Data's Rumba terminal-emulation software. A Centrum communications server acts as a gateway between the notebook and the mainframe holding the data. Sales-team members have unlimited access to all the product, market-research, and competitive analysis data relevant to their territory. They cannot, however, use the connection to get data on their coworkers' accounts. Contact among the staff is maintained via Microsoft Mail and voice mail.

Productivity was not the only concern. Maintaining the legacy systems was becoming expensive. Also, the end of a lease agreement prompted Xerox's New England branch to adopt the virtual-office plan earlier than expected. The age of the company's old digs meant that rewiring for a new network would be expensive.

Pittman expects Xerox to accrue $250 million annually from the project. About $30 million to $50 million of that will come from cutting leased office space by 30 percent. Most of the 65 district offices were downsized, and about half of the 50 area sales offices were closed. In addition, Xerox saves money by processing customer invoices more efficiently, and fewer people are needed to maintain databases and mainframes. Some people were reassigned, and some were part of a layoff, although Xerox declines to provide specific numbers. On top of that, Pittman foresees a 20 percent gain in sales productivity. When you consider those numbers, the project's estimated $100 million price tag to implement the client/server network, renovate facilities, and train the staff looks like a bargain.

Before and After

Over 10 years ago, Xerox was one of the first companies to adopt LAN technology companywide, but this proved to be a disadvantage for the virtual-office plan. The existing corporate network could not support the mobile sales force. That network is based on Xerox Star network software and runs GlobalView terminal-emulation software with Xerox Model 6085 terminals and a mainframe.

Although the proprietary network was ahead of its time, especially in its ability to transmit graphics images, it was slow and incompatible with the current industry standards. "We were highly arrogant about [our] technology and tried to protect it," says Lewis. Protecting that system kept Xerox blind to technology that its competitors and customers were using.

All the details of the client/server network that will replace the old network have not been worked out at this writing. It will be based on Novell NetWare 4.1 running an Oracle database engine. The servers will be Sun SolarStation 2000s, and the clients will be mostly Windows PCs and portables with a few Macs.

In Waltham, each virtual-office worker has a Compaq Elite 440C notebook. This system has a passive-matrix color display, a 340-MB hard drive, a Megahertz 14.4-Kbps PCMCIA modem, and a Thomas-Conrad PCMCIA Ethernet adapter. Software includes Microsoft Office, a communications package, a set of Xerox forms, and several megabytes of database files.

The Compaq notebook was not Xerox's first choice. The company planned to use the IBM ThinkPad 750. Pilot programs showed that the ThinkPad was "the first laptop with more than a six-month life span," says Mike Radigan, program manager for Xerox's U.S. customer operations division. However, lack of availability forced Xerox to look elsewhere.

Still, the Elite 440C has a number of features that appeal to mobile workers. Its power supply is internal—there is no "brick" to carry around. The processor, screen, and hard drive are user-upgradable. This improves the system's life span and makes service easier. This is important because Xerox does its own service on the units to reduce costs and minimize downtime. Compaq provided service training and has authorized Xerox to order parts directly. It also keeps a reference model loaded with the same applications that Xerox uses if Xerox calls with a problem it cannot solve itself.

Making It Work

The Xerox experience provides three key lessons for companies thinking about implementing the virtual-office concept. First, do testing to be sure you have adequate equipment and an information infrastructure, and identify potential glitches. Second, give the people involved the training and resources they need. Finally, redesign your facilities to maximize their efficiency.

Xerox's pilot programs quickly brought issues to light that might have meant disaster on an actual rollout. Many of the notebooks from vendors other than Compaq and IBM proved to be unreliable. When the tests began, Xerox was also worried about notebook performance and hard drive capacities. The tests told the company just how close existing models came to its requirements.

The speed of the remote connection was another big concern. It was clear that ISDN availability was too variable and too expensive. Radigan estimated that, for a test in Phoenix, providing ISDN for each participant would cost roughly the same as the notebook. With about 4000 potential virtual-office workers in the company, Xerox decided that fast modem connections over POTS (plain old telephone system) lines would have to do. However, the company continues to evaluate ISDN and other alternatives, such as 28.8-Kbps modems.

continued

VIRTUAL OFFICE, TANGIBLE BENEFITS

The Problems



- Selling complex office products and support services requires on-site meetings, but sales representatives didn't have time to meet with the 3000 potential customers in the region.
- The sales staff spent 30 percent of its time chasing essential product and customer information stored on the legacy system.
- Maintaining the legacy system was expensive.

The Solutions

- Give the sales force notebooks.
- Close down the central sales office.
- Develop a centralized, quickly accessible data repository.

The Benefits



- A possible annual payback of $250 million from increased sales, lower computer costs, reduced office rent, and staff reductions.

Lessons Learned

- Run pilot programs to gauge equipment and information-infrastructure requirements.
- Fully train and equip the staff.
- Redesign your facilities to maximize efficiency.

What Experts Say About the Virtual Office

Not all companies find success with virtual offices. What separates the winners from the losers often comes down to some basic "dos" and "don'ts."

DON'T force clerical tasks onto salespeople.
"You have now taken somebody with talent and made them into a clerk," says Ken Dulaney, vice president of mobile computing at the Gartner Group (Santa Clara, CA). Xerox's key goal was to have its sales force spend more time with customers. That would be impossible if salespeople took on new tasks. Dulaney suggests that in many cases you will get better results by giving your best salespersons secretaries rather than placing them in a virtual-office environment with inadequate support.

DON'T use mobile technology as a means of cutting costs.
You can't just send off your sales force with modems and notebooks and expect good results, Dulaney warns. Xerox changed its entire information infrastructure, for example, so that its sales force could easily access the data it needs remotely.

Do work harder for better communication.
Important information on products, policies, and key accounts is not easily disseminated in a virtual office. Regular staff meetings to review goals and share information are a must, says Jaclyn Kostner, whose consulting firm Bridge the Distance International (Denver, CO) specializes in helping companies manage the virtual office. "[The sales staff] must be able to reach people in real time," she adds. Kostner recommends giving pagers or cellular phones to key people, requiring the staff to update voice-mail greetings daily, and to frequently check for messages.

DO consciously develop team spirit.
Lack of communication can also diminish the sales staff's morale and effectiveness. Kostner knows of one mobile staff that learned of a coworker's $10 million sale 45 days after the fact. This angered some people who would have sought advice from the coworker. In situations like this, says Kostner, "learning stays in little puddles." Worse, this situation may promote distrust among a staff. A buddy system, such as the one Xerox used, provides "someone else to share the pain as well as the successes," says Kostner.

To help relieve anxiety about the change, Xerox provided both classroom training and ongoing support for its virtual-office employees. Many of them had never used notebooks or Windows, nor had they ever made a remote connection. "Dialing in was something totally foreign to them," says Joann Halle, marketing manager for the New England operations. Yet other sales-team members had PCs at home and used modems; some of them even looked forward to the change.

Bob Couch, a sales analyst in the Waltham office, is a prime example. He likes having quick access to information for which he used to drive long distances. Couch has optimized the virtual-office concept further by creating templates in Microsoft Word for all the forms he uses.

After receiving formal training on the new systems and software, each employee who had little experience was assigned a buddy. The buddy was a fellow sales-team member who had more knowledge of computers. During the three-week transition period in Waltham, the buddy was on-call 24 hours a day. If someone had a crisis at 2:00 a.m. while working on a proposal, help was only a phone call away.

The buddies continue to be available as long as they are needed. If a problem is too vexing for a buddy to solve, the Waltham office has a CNA (certified NetWare analyst) on-site. It also has access to a CNE (certified NetWare engineer) provided by systems integrator EDS, which set up the notebooks. To Lewis, the buddy system was a success. She says her staff "feels like they can talk to customers at any level."

Each virtual-office worker has a home office with a phone line and printer, both of which Xerox provides. Xerox gives each employee $200 to set up a home office. The company has also set up the Waltham office with a classroom that's equipped for videoconferencing. Now employees can get on-site training for new products or procedures without traveling to a central training facility in Leesburg, Virginia, as they did in the past. *continued*

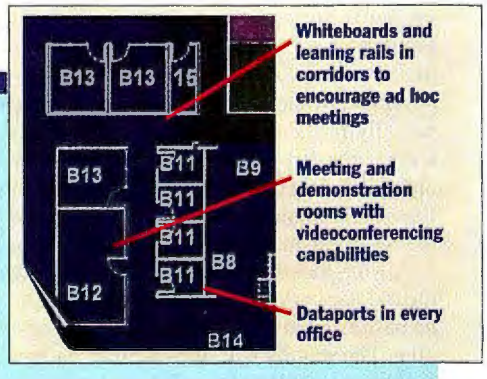
Where Virtual-Office Workers Meet

Xerox's Waltham office looks and functions like an airport red-carpet lounge for frequent fliers. Both provide an office away from the office for transient workers.

At the Waltham facility, you see rows of phone booths, work cubicles, lounge areas, and dataports everywhere. Strategically placed leaning rails, whiteboards, worktables, and chairs encourage chance encounters among the staff. Thus, information is more easily shared. "Everywhere a person could conceivably sit down, he or she should be able to plug in a laptop and become productive," says Sean Connellan, who is the manager of strategic planning and operations support in Xerox's corporate real estate organization. The facility in Waltham also has product demonstration areas, meeting rooms, a mailroom, and classrooms for training.

The Waltham building has about 40 percent less floor space than the old regional sales office had, but it still supports the same number of people. However, it does not appear to be cramped at all. Many of the offices are, in fact, empty.

To schedule on-site meetings in Waltham, staff members connect to the network to determine room and equipment availability and to reserve any necessary equipment. A touchscreen located in a lounge provides for up-to-date resource scheduling. According to Connellan, however, this scheduling system is only a trial and might not be deployed companywide.





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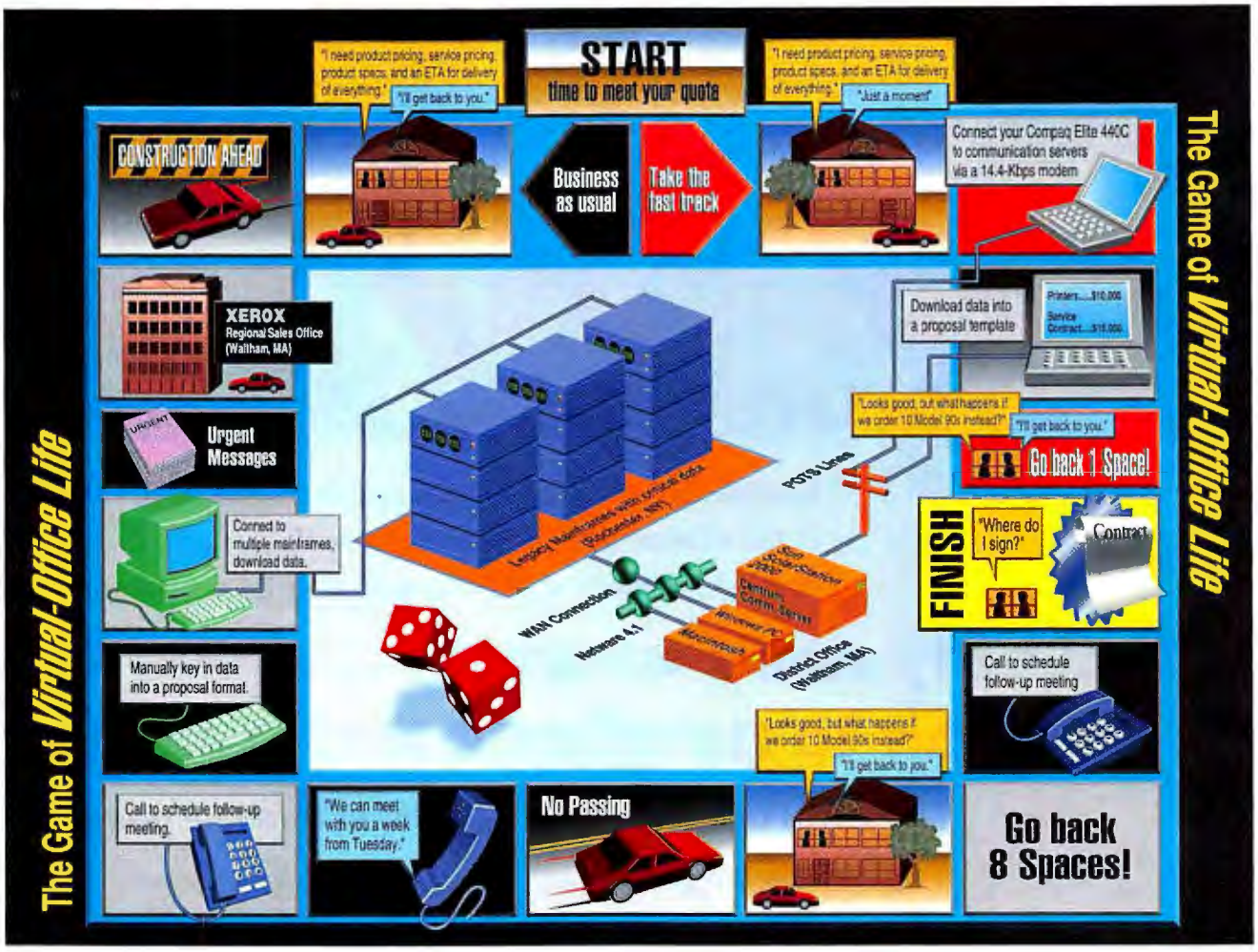
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Imperfect Success

Xerox has not yet perfected its virtual-office implementation. Perhaps the most significant issue to be resolved is moving from the legacy system. By the time you read this, all the company's U.S. sales operations will have the capability of working from virtual offices. The major European divisions will follow by the third quarter of this year. But Xerox will not shut down the mainframes until next year.

All the "real support" is still in the mainframe, says Pittman. In practical terms, a sales representative connecting remotely won't know the difference between getting data from a legacy mainframe or from a client/server network. The trouble is that some employees with whom the virtual-office workers need to communicate still use only the legacy system. This presents a problem with E-mail. Thus, the Waltham office still maintains some of the old Xerox systems for access to legacy services.

Both the Xerox planners and the virtual-office staff would like to see improvements in the portable systems. Wish-list items include a bigger hard drive (the Waltham staff did not have enough room to install XSoft's GV-Win, which provides connectivity to the legacy system), a better color display, and a faster modem. In most cases, 14.4 Kbps is adequate. But downloading a bit-mapped form is still too time-consuming.

Smaller problems still abound. Lewis cites the need for people to learn better E-mail etiquette; some staffers tend to unnecessarily copy everyone on the E-mail messages they send, clogging up mailboxes. Couch would like to see all sales personnel have a CompuServe or other on-line account. This would give them access to the Internet and to on-line users groups catering to Xerox products, not to mention another avenue of communication with customers.

Down the Road

Xerox is currently examining the next step in its information-system strategy: the implementation of an object-oriented approach to data management. It is too early to know which model or platform the company might use, but Pittman sees some important benefits to using object-based applications.

First, he and Pat Wallington, who is chief information officer and architect of the strategy, expect the upkeep of the applications to be easier and that local managers will be able to build more of their own reports and applications. The company will also be better able to adapt applications to different geographic needs. But perhaps most important, Pittman sees the object-oriented approach as insurance that Xerox "does not wind up with a new legacy system." ■

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Michael Nadeau is the author of the BYTE Guide to CD-ROM *(Osborne/McGraw-Hill, 1995). You can reach him on the Internet or BIX at miken @bix.com.*



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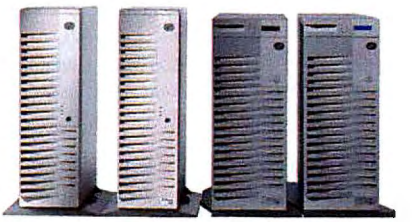
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Apple's New Operating System

TOM THOMPSON



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System 8.0 offers up-to-date OS services, such as limited preemptive multitasking, concurrent I/O, and memory protection

Next year, Apple will release System 8.0, a major revision of its Macintosh OS. Code-named Copland, it supports two diametrically opposed goals: to deliver sophisticated OS services with a growth path to future features, yet run existing Mac software.

It was the Mac's extensive software base that forced Apple's engineers to limit Copland's capabilities in the areas of memory protection and task scheduling. But they were still able to build in sophisticated OS services, such as threads, task and I/O synchronization, hardware abstraction, and virtual memory support.

Copland is a complete redesign of the Mac OS. Like all modern OSes, Copland consolidates all its core OS services into a compact microkernel. This microkernel, along with a completely revamped I/O subsystem, provides powerful OS services without impacting performance. (For an overview, see the text box "Copland OS Features at a Glance" on page 60.)

Copland's microkernel, native OS software, and native applications are packaged as code fragments. Thus, Copland will be released first on Power Macs, CHRP (Common Hardware Reference Platform) systems, and PowerPC-based clones. Apple is still deciding whether to release a 680x0 version. Copland is expected to require 8 MB of RAM and 40 MB of disk space (20 MB for the actual code and 20 MB for a swap file).

Not all of Copland's improvements originate in the microkernel. Other parts of the OS, such as the Finder and portions of the Toolbox, have been enhanced to provide better performance or to improve the UI (user interface). For example, Copland has a scalable UI that can accommodate a user's expertise level. For the programmer, object-oriented interface elements make an application's UI much easier to build.

Safeguarding Memory

Copland's 32-bit memory architecture manages a maximum address space of 4 GB. Unlike System 7, Copland partitions this space so that 1 GB is allocated for the OS code, OS tasks, and I/O buffers. The remaining 3 GB is for applications.

Copland sets up a variable-size Cooperative Toolbox Environment space (henceforth referred to as simply the Cooperative space) where existing Mac applications and portions of the Mac Toolbox execute. The microkernel can create other, independent spaces as required for specialized applications. The PowerPC uses information from its MMU's (memory management unit's) PTEs (page-table entries) to manage memory accesses. Copland programs the PTEs to establish several types of controlled access, each of which is then enforced by the MMU. These controls include write protection, address-space isolation, and execution-mode protection.

continued



Copland OS Features at a Glance

BETTER PERFORMANCE. The first Power Macs achieved their well-known stability and compatibility by simply executing large amounts of the time-proven 680x0 Toolbox code in an emulator. With Copland, this situation is reversed: It's comprised mostly of native PowerPC code, so calls to the microkernel services benefit directly from the PowerPC's processing speed.

It's important that Copland's device drivers are reentrant native code. Thus, they provide better raw throughput over what's possible using emulated drivers, and concurrent I/O operations are supported. A native file system boosts file I/O rates, especially for virtual memory. It also offers new capabilities, such as the ability to handle hard drives up to 256 TB in size and individual files up to 2 GB in size. Finally, an improved 680x0 emulator executes the remaining portions of the 680x0 Toolbox code, and any 680x0 applications, significantly faster.

The microkernel also has a preemptive task scheduler that helps overall performance. As with other OSes, this task scheduler juggles task activity so that when one task gets blocked—perhaps while waiting on pending I/O or for access to an exclusively owned resource—other tasks still execute.

This keeps the overall system running efficiently rather than stalling when a program waits for an I/O function to complete, as is often the case with System 7. While the kernel, I/O services, and server programs created by Copland-savvy applications execute preemptively, for reasons of compatibility, existing Mac applications still have to execute cooperatively.

A MORE STABLE OS. The microkernel improves reliability through the use of memory protection, separate address spaces, and user/supervisor execution modes. Again, for compatibility purposes, this memory-protection mechanism has limitations: Applications and nonreentrant Toolbox code reside in a single Cooperative space and can trash one another, but not the entire OS.

Because of the microkernel's modular design, Apple can release portions of the OS for shakedown before Copland ships next year. For example, drivers, network services based on Open Transport, and a faster 680x0 emulator will be released with the PCI-bus (Peripheral Component Interconnect) Macs that are due out this summer. Users can depend on these services' being reliable in Copland because they will sport any bug fixes and performance-tuning accomplished during the interval.

AN EXTENSIBLE ARCHITECTURE. This is an outgrowth of Copland's modular design. Portions of the OS can readily be replaced to, say, support a new volume format or an imaging engine without having an impact on other OS services.

In recognition of the fact that third-party vendors often extend the Mac OS in new and useful ways, Copland's microkernel offers a well-documented native patching mechanism. For example, both the new File Manager and the high-level Toolbox supply hooks so that these portions of the OS can be readily extended.

HARDWARE ABSTRACTION. Copland's ship date was delayed so that hardware dependencies could be eliminated from every part of the OS but the drivers. Unlike previous versions of the Mac OS, Copland is not ROM-based: Instead, all the OS and Toolbox code resides in disk files.

Open Firmware, an evolving IEEE standard, is used to bootstrap the computer. This prepares Copland for the new PowerPC system hardware standard, CHRP (Common Hardware Reference Platform), which was jointly proposed by Apple, IBM, and Motorola. (For details, see "New PowerPC Standard Supports Macs," March BYTE.) This hardware abstraction also assists Mac clone vendors: They can readily add custom hardware to their system designs to add value or cut costs without requiring a drastic revision of Copland.

All program code and invariant data (e.g., an interface object, such as an error dialogue string) are marked as write-protected. This feature prevents an errant memory access from corrupting key data or program code. Any such attempt creates a write-protection exception, which is fielded by an exception handler. Copland has a number of default handlers that attempt to make a graceful recovery from such exceptions as addressing errors, illegal instructions, and arithmetic overflows. Special-purpose applications can install their own handlers.

Portions of the OS reside in separate address spaces established by the MMU. This arrangement effectively walls off these parts of the OS from applications. Current System 7 Mac applications must run in the Cooperative space. Certain types of programs, such as extension code and background-only applications that don't make use of the GUI, can be placed in separate address spaces for additional memory protection. In the future, when the Toolbox code is revised for Gershwin (the code name for the next major Mac OS release), Mac applications will reside in their own distinct address spaces, protected from each other.

But not all the OS code and system data can be isolated. Certain information must be shared globally with applications and other OS tasks. Such code and data are protected by the execution-mode mechanism (see the figure "Copland Memory Map" on page 62). Unlike previous versions of the Mac OS, Copland distinguishes among instructions executing in the processor's user or supervisor mode. (System 7 also made this distinction when running virtual memory, but it was only to support the page-faulting mechanism.)

The microkernel, I/O services, and device drivers operate in supervisor mode (which is also known as privileged mode), while applications run in user mode. This arrangement restricts memory accesses so that only privileged code, such as the microkernel, has the ability to modify system data structures.

Applications can access this data, but only indirectly by invoking a kernel service through an API call. These calls, which use the PowerPC's exception mechanism, are fast and efficient. In combination with write protection, this arrangement lets applications have read-only access to globally shared data structures.

The most vulnerable section of memory is the Cooperative space, where applications reside. It offers no memory-space isolation or execution-mode protection. Apple's engineers made it this way so that this area would resemble the current System 7 run-time model and thus provide an environment where existing applications can run.

While the Cooperative space cannot pro-

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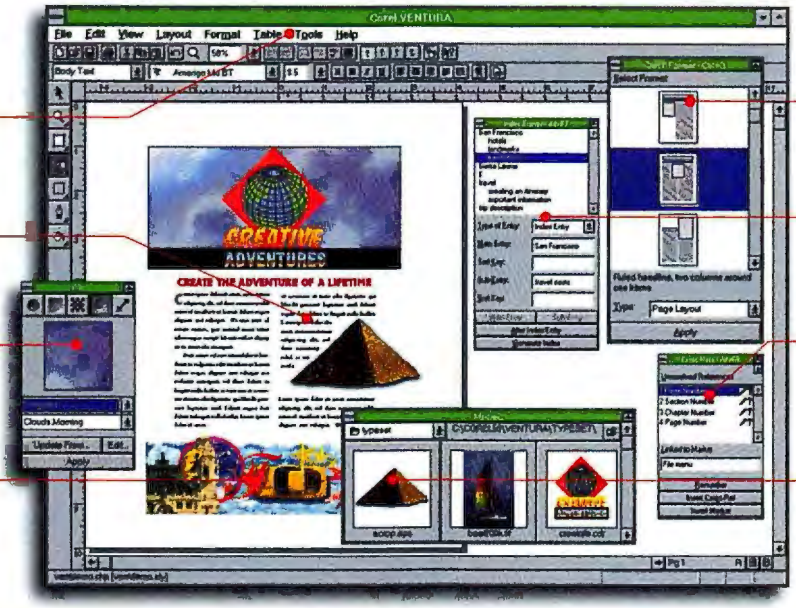
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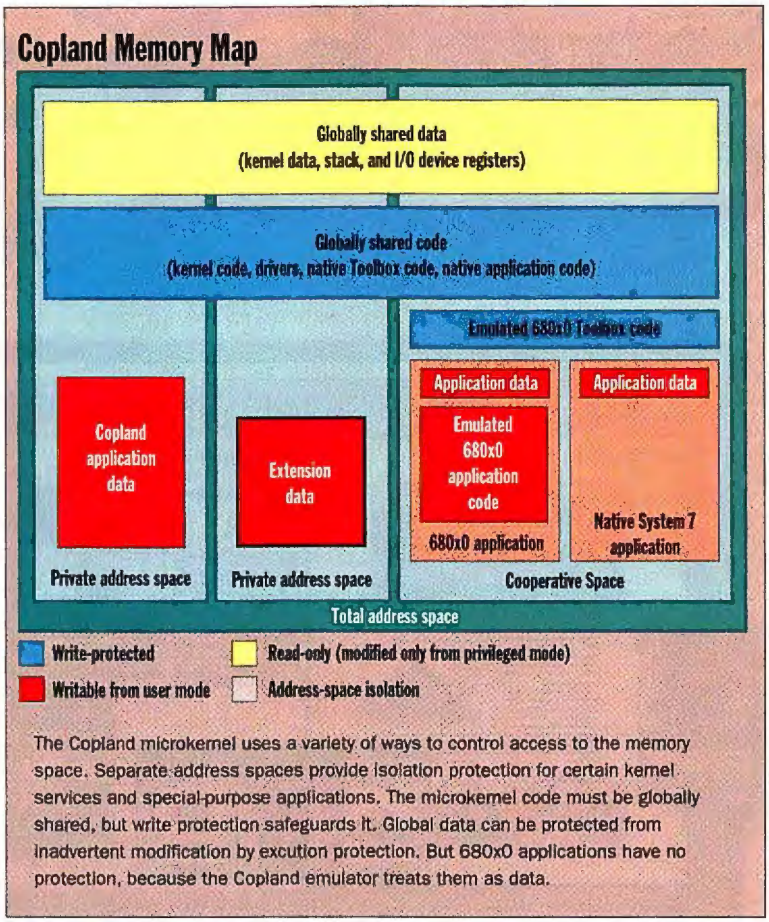
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vide memory-space isolation or execution-mode protection, it offers limited memory protection. Recall that all native program code, regardless of its address space, is write protected. A wild access into a native application's code—or into the Toolbox code residing in this space—causes an address exception. In such a case, Copland's exception handler terminates the offending application.

An errant application can trash another application by altering its data structures, since such information can't be marked as read-only. A misbehaving application can also corrupt data used by the Toolbox code residing in the Cooperative space. In the latter situation, the Cooperative space terminates and you lose all your work inside the applications. But you can restart the Cooperative space, and—because of the memory protection—the OS itself, any network sessions, and the state of the file system are still intact. Any special-purpose background applications living in separate address spaces, such as a database engine, are also safe in such a situation.

This design compromise shields the Copland OS and native applications from most malfunctioning programs. A program would have to precisely hammer a small range of key data addresses to damage another application. In the worst possible scenario, it could only bring down the Cooperative space. This a major improvement over the current situation, where all of System 7's code and all applications are wide open and vulnerable to a stray memory access.



The Copland microkernel uses a variety of ways to control access to the memory space. Separate address spaces provide isolation protection for certain kernel services and special-purpose applications. The microkernel code must be globally shared, but write protection safeguards it. Global data can be protected from inadvertent modification by excution protection. But 680x0 applications have no protection, because the Copland emulator treats them as data.

A New Run-Time Model

Copland sports a threaded run-time architecture for the microkernel and various parts of the OS. A *thread*, an independent course of execution, has its own stack and registers. It relies on resources obtained by the parent process, such as memory or access to an I/O device. Copland threads are similar to Unix Mach threads, but they are called *tasks* in Apple parlance. (The remainder of this article will use the Apple term.) Copland's task scheduler schedules tasks preemptively according to priority and time intervals.

Copland tasks are typically part of a team, which makes them similar to Unix Mach processes. A *team* is composed of one or more tasks and other kernel resources. Only the tasks within a team execute, while the resources supply the data required by the tasks. An address space can be occupied by multiple teams, such as the Cooperative space. However, to help implement Copland's memory-protection strategy, tasks within a team can't migrate to other teams, nor can teams move between address spaces.

A Copland *process*, as in System 7, is a thread of execution that represents an application started by the Process Manager. However, while a System 7 process has only a single thread of execution, a Copland process uses a team, which consists of a main task, resources, and any other tasks started by the main task.

An application's main task can create secondary tasks, which can be scheduled preemptively as long as the secondary tasks don't make use of the GUI or the Event Manager. The restriction for not using such calls is that these Managers, especially QuickDraw, still have nonreentrant code and thus can't be used in a preemptively scheduled task. These secondary tasks can manage network, disk-I/O, or computationally intensive tasks while the main task handles the main event loop that processes user events.

The cornerstone to the new memory-protection and reentrant-code capabilities discussed thus far is the Power Mac's run-time architecture. It's based on shared libraries of code fragments that are functionally similar to DLLs. This is radically different from how System 7 resides in memory: a monolithic code block that must stay RAM-resident. Because each of Copland's services is resident only while in use, applications can use more of the 8 MB of RAM that Copland occupies.

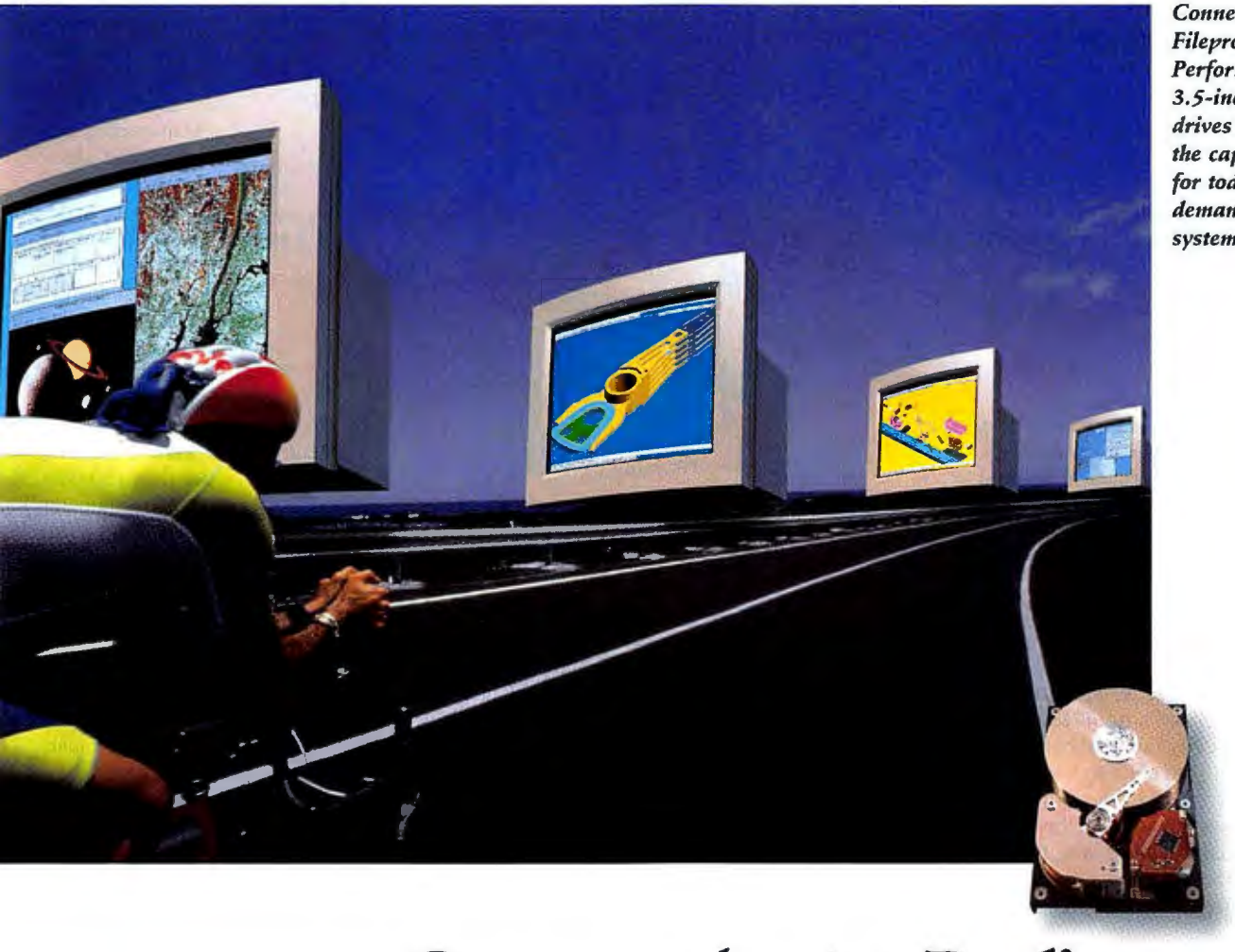
When you create a code-fragment shared library, you can specify how its global data is to be shared. The Code Fragment Manager, the part of the OS responsible for managing code fragments, calls the microkernel to program the PowerPC's PTEs as it loads and unloads code fragments. A shared library's data can be per-context (i.e., each team has its own instantiation of the global data), privileged-only (i.e., the data is readable by all teams but can be altered only by privileged-mode code), or made up of systemwide globals, which are accessible and writable by all tasks.

On Schedule

The nerve center that coordinates all of Copland's activities is its preemptive task scheduler. Only those tasks that are written in reentrant code and that make use of reentrant Toolbox Managers can be scheduled preemptively. The reentrant Managers include any kernel services, the new File Manager, the Device Manager, the Apple Event Manager, all network protocols, and a new memory Manager called the Pool Manager (just to name a few).

Therefore, a task that makes use of I/O or networking services, or one that performs background processing, such as a database search or floating-point computations, can be preemptively scheduled. However, any task that makes use of the System 7 Memory Manager, the Event

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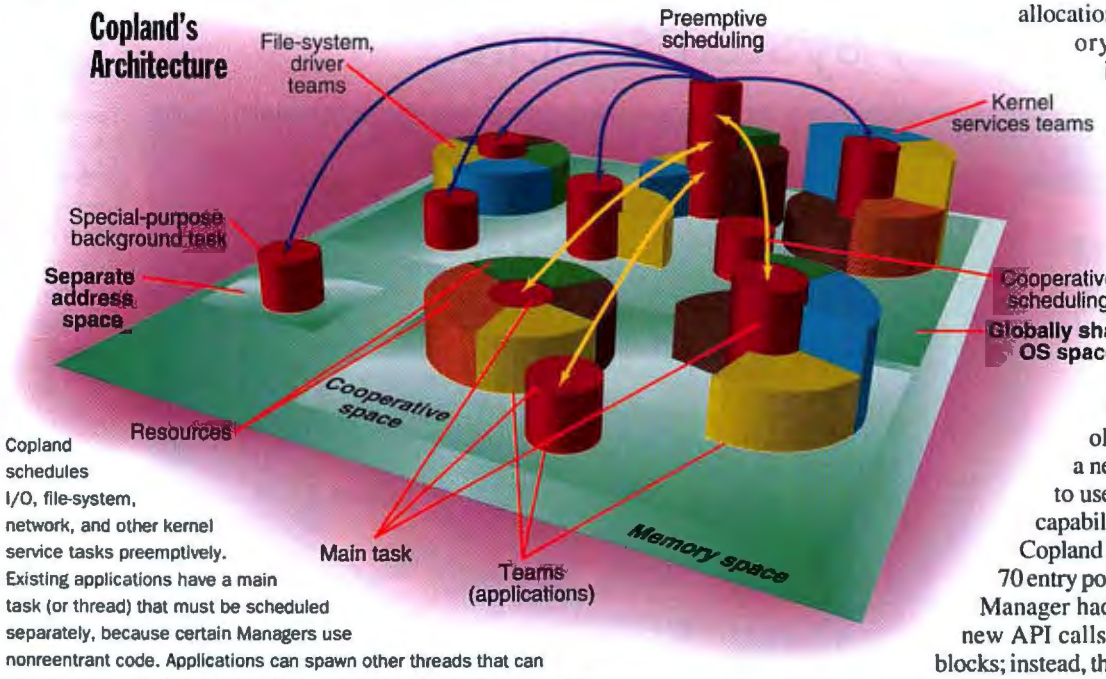
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Copland schedules I/O, file-system, network, and other kernel service tasks preemptively. Existing applications have a main task (or thread) that must be scheduled separately, because certain Managers use nonreentrant code. Applications can spawn other threads that can execute preemptively as long as they make use of certain kernel services.

Manager, or QuickDraw can't. The scheduler arranges these tasks to execute just one at a time to satisfy the nonreentrant nature of these APIs, as shown in the figure "Copland's Architecture" above.

Typically, an application's main task contains the calls to `WaitNextEvent()` and—by way of the Window or Dialog Manager—to QuickDraw, and thus has a limited execution schedule. `WaitNextEvent()` calls kernel services, which synchronizes the team's data with the main task.

A main task can create other, secondary tasks that have the ability to execute preemptively as long as they avoid use of nonreentrant Toolbox code. In addition, it's up to the programmer to use the main task to enforce data synchronization among other tasks. But the new File Manager and Device Manager API calls provide a completion notification mechanism—either by posting a new type of event or setting a semaphore—that notifies the main task when an I/O operation concludes. The kernel provides a variety of synchronization services, ranging from semaphores to a sophisticated message system that can pass blocks of data between tasks that have different privileges and reside in different address spaces.

The task scheduler has 31 priority levels. Priorities deal with such details as real-time data handling (e.g., video and sound), responding to an application's user interface, network activity, and background tasks. The scheduler is smart enough to resolve scheduling conflicts brought about by lower-priority tasks having exclusive access to kernel resources.

While this design has its limits, the major win here is that it allows System 7 applications to continue to run. While these applications execute cooperatively, the kernel and most OS services execute preemptively. As a result, no longer does the system halt while an application tracks your mouse position in a menu, as is the case with cooperative multitasking under System 7. Instead, menu tracking continues, and so does kernel, networking, disk I/O, and other tasks.

Performance Improvements

It's a tribute to the might of the PowerPC processor that Power Macs deliver ample performance, even though more than half of System 7's OS and Toolbox code is 680x0 code running in an emulator. Copland, despite the overhead that the kernel services exact, should run faster, because 95 percent of it is native code.

For example, Copland integrates native versions of QuickDraw GX and PowerTalk, its collaboration software. The remaining 5 percent of the OS uses 680x0-processor-specific code, such as the Segment Loader. It doesn't make much sense to do a native implementation of these parts of the OS. A faster 680x0 emulator uses dynamic recompilation rather than static execution to boost the speed of this code, as well as any 680x0 application running on the system.

To improve memory performance, a new pointer-based Pool Manager provides faster allocation and access to memory blocks. The Pool Manager is also reentrant, so it can be called by the kernel and various secondary tasks.

The new File Manager employs improved algorithms and native code to deliver increased throughput. It continues to support the old API, but it provides a new API that's simpler to use while offering more capabilities. For example, the Copland File Manager has only 70 entry points, while the old File Manager had more than 150. The new API calls don't use parameter blocks; instead, they use smaller logical data structures that carry shared data between file-system calls for better efficiency. The File Manager also uses reentrant code, so tasks can have concurrent file I/O operations in progress.

Copland's virtual memory subsystem is faster, more robust, and always active. It doesn't interfere with overall system performance because it's smarter and more flexible about memory paging. Under System 7, a swap file representing a fixed memory partition had to be built at boot time. Under Copland, a swap file is built only when the Process Manager launches a new application. This way, the swap space can be disjointed files on the hard drive, and it need only be as large as the combined memory demands of the OS and any running applications. This arrangement also reduces memory fragmentation. As in the native version of System 7, file mapping is used to reduce I/O to and from the swap files.

Hardware Independence

Copland's ship date was delayed by at least six months so that a HAL (hardware abstraction layer) could be added. The HAL hides the hardware details from the kernel code so that the code can be written without any dependencies on a particular machine configuration. To this end, Copland no longer requires Mac ROMs to function. Instead, a set of bootstrap ROMs use the Open FirmWare boot process to locate the start-up drive, load Copland into memory from a disk file, and transfer control to it.

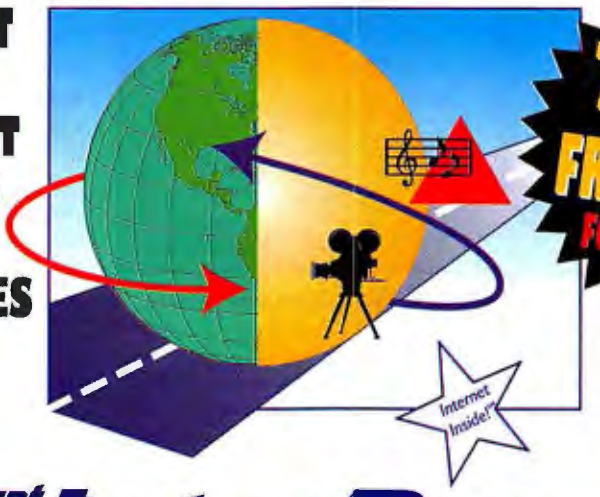
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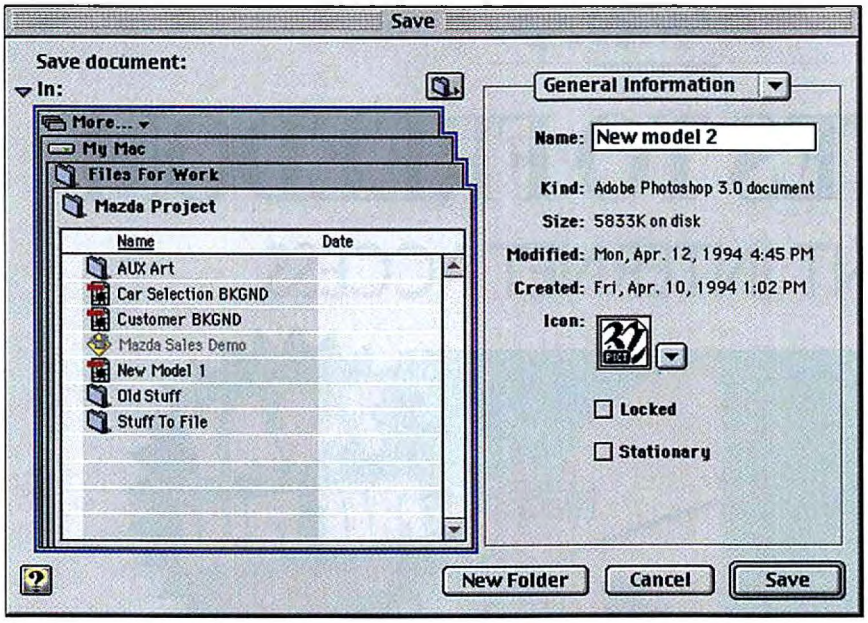
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Circle 107 on Inquiry Card.



The new Standard File dialog box, presented by Navigation services. Notice the nested folder hierarchy in the window.

a diverse array of hardware. Adding a new type of device to Copland means simply adding a new device driver rather than a modification to the OS. For example, to add a low-cost PC keyboard to its design, a Mac-clone vendor provides a keyboard-driver file. Inside this file is driver code that consists of two parts: one that's hardware-specific, and one that hooks into Copland's abstraction layer. The latter portion mediates communications between the Mac OS and the hardware-specific part of the driver.

A Name Registry provides a certain level of hardware abstraction and driver-design consistency while providing device control. The Name Registry is an object database that stores information about the various devices that register themselves with Copland. It also provides for dynamic driver loading and unloading, which is necessary for devices that can be hot-swapped, such as PCMCIA cards and PowerBooks intended for docking.

Last but not least, Copland uses Open Transport to implement network services. Open Transport is based on network standards from the X/Open Group, including the XTI (Transport Interface) and the DLPI (Data Link Provider Interface). Apple's engineers used the Streams standard from Unix System V for the protocol environment.

Open Transport thus provides network services through a single set of APIs that let applications transparently access network services using multiple protocols. Open Transport implementations of the AppleTalk and TCP/IP protocols have been completed, and IPX and serial communications protocols are currently in the works. Open Transport uses native drivers for maximum performance.

Easily Extendable

To allow Apple and third parties to extend Copland's features in the future, a new, well-documented, patching API is available. The functions of this new patching API shift from the 680x0-processor-specific, A-trap table to the processor-neutral, transition-vector mechanism used by the Code Fragment Manager. *Transition vectors* consist of pointers that aim at the entry points of a shared library's functions.

This mechanism shift confers two advantages. First, patch code won't incur the overhead of a context shift between processor-instruction sets when a switch occurs into the emulated 680x0 environment and back. This overhead wasn't significant when the bulk of the OS was still 680x0 code, but it becomes substantial with Copland, which is chiefly native code.

Second, the transition vectors provide finer granularity over what's patched and can supply bookkeeping information. For example, many A-trap entries actually dispatch to several Toolbox functions. To patch the file `Open()` function, with the old patch API you had to patch the file system's entry point (`FSDispatch()`) in the trap table and then filter all uses of this call until you received an `Open()` request. This method was prone to failure and could introduce unwanted side effects in all the functions called through that entry point. With the new patch API, you patch only the `Open()` function. The bookkeeping information can be used by a developer to order or disable patches for debugging purposes.

Finally, parts of Copland offer hooks to facilitate patching. The virtual memory subsystem uses *backing objects*, which are abstract entities that make up part of the page-fault mechanism. Normally, backing objects are registered with the OS and simply map sections of physical memory to swap files. However, a third-party vendor might modify a backing object's behavior so that a page fault referenced by it becomes an I/O request. This I/O request then compresses the data and writes it into a memory cache, mimicking the operation of Connectix's RAM Doubler utility.

The new File Manager allows extensions, so it can be enhanced and new foreign volume formats can be supported. It also provides notification events so that when a change occurs in the file system (e.g., a Type III drive card is removed from a slot), the OS and applications can respond to the change.

A New Look

So far this article has concentrated on Copland's infrastructure. However, there are visible changes to the UI as well. Some of these changes assist the user, while others make the programmer's job simpler.

For instance, some existing Toolbox Managers have been enhanced to make it easier to use certain interface elements. For example, the Menu Manager now has built-in support for tear-off menus and sticky menus, which formerly required extensive patching to implement. The Menu Manager also lets the user hide the menu bar or add a permanent menu (i.e., one that's present in all applications).

The Window Manager now provides floating and modal windows as standard fare. It also introduces new features, such as multidirectional window sizing and background patterns within the window's content area.

The Dialog Manager and Control Manager now offer active feedback during mouse tracking (which is essential for live document scrolling). It now also lets the user chose dialog box items via keyboard input.

In System 7, the interface elements used by these Managers (e.g., a window or a menu) consisted of stand-alone resources known as definition functions, or *defProcs*, with only one entry point. To implement a custom control or window, you had to write your own defProc resource.

For compatibility, Copland supports existing custom WDEF, CDEF, MDEF, and

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COPLAND HOT SPOTS

It's normal to expect some software-compatibility problems due to subtle changes that are introduced in a new OS release. Since the application run-time architecture has undergone sweeping changes under Copland, you might anticipate major compatibility problems. However, Copland supports the old run-time environment and APIs along with the new ones, so such problems might be minimal—at least on paper. The matter won't be settled until Copland ships, but we can identify the potential problem areas. Possible culprits are listed below and are arranged in order from best-behaved to worst-behaved.

- **Applications that make heavy use of network communications, such as mailers, group schedulers, and software-control packages. That's because Copland uses Open Transport to implement protocol stacks and network services. Also at risk are telecommunications applications, since Open Transport manages serial communications protocols. But because Open Transport will be released this summer, software vendors will have an opportunity to revise their programs. The bottom line: Expect to use the most recent version of these applicatons with Copland.**
- **Drivers. The revised driver architecture is bound to create some problems for vendors and users alike. The PCI-bus Power Macs to be introduced this summer will be a proving ground for the native implementation of PCI drivers. However, Copland's memory-protection scheme and the need for reentrant code could create new problems. The bottom line: Make sure the PCI card or new driver extension is Copland-compatible.**
- **Extensions and Control Panels with initialization code. Since Copland uses a native patching mechanism, an initialization-code resource that patches the old A-trap table simply breaks. Also, there will be many problems arising out of such code being loaded into disparate address spaces. The bottom line: Prepare to pony up the cash to upgrade all your favorite Extensions and Control Panels.**

MBDF defProc resources. But Copland improves the situation with an object-oriented interface architecture based on the SOM (System Object Model). Instead of using defProcs, SOM helps implement Mac OS interface elements as IDOs (Interface Definition Objects). An IDO has multiple entry points, one per method. A programmer can write a custom IDO by subclassing it from a base IDO, thereby causing it to inherit all its desired behaviors. The programmer then quickly adds custom behavior by writing code to override certain methods.

Important here is the fact that, while QuickDraw is not reentrant, IDOs are. These new interface objects thus pave the way toward a future OS based on a reentrant imaging engine.

Also important, text is handled by an abstract data type known as a *text object*. Text objects remove the limitations of C or Pascal text strings and provide the means for manipulating multibyte foreign languages. Text objects use a Unicode converter to handle conversions between different-language text encodings. They also provide for a smooth migration to complete Unicode text encoding in a future OS release.

Copland provides several new Managers to handle the system from the user's perspective. An Appearance Manager provides new human-interface components—such as sliders, a progress indicator, and an expansion triangle—that formerly required extensive programming to implement. It also provides new APIs that draw interface elements, such as bevels, for these components.

A Navigation Services Manager supplies new standard file dialog boxes that expedite the selection of files, applications, folders, and volumes. Its behavior can be easily extended so that this window can act as a file viewer or be used to browse other data containers (e.g., a mailbox or archive) rather the file system (see the screen on page 66).

From the user's point of view, some of these interface benefits are obvious. Others aren't so obvious but are just as useful. For instance, the Finder is now multithreaded, so you can handle several different file operations, such as copying several files simultaneously, launching other applications, and emptying the trash, all at once.

Copland's UI is now scalable, which means that its appearance and behavior can be tailored to the user's expertise level. While details are still sketchy, Copland should closely resemble At Ease to a novice user, where items such as hard drives and the Trashcan are hidden from view. An expert user can have the familiar Finder Desktop layout, with all its hard drives, remote servers, and PowerTalk mailbox.

Copland's scalable UI means that as a user gains experience with the Mac, he or she can apply skills learned at the novice level toward the more advanced UI environment. This isn't the case with Microsoft's Bob, where the interface skills gained by a user don't translate to using Windows.

The Best Gets Better

Copland provides a much-needed revision of the Mac OS. It offers speed, reliability, and modern OS services through its native code, preemptive multitasking, I/O concurrency, and memory protection. The compromises made in task scheduling and memory protection are reasonable ones, particularly since they protect your software investment by allowing existing software to run. Reliability shouldn't be a concern, because parts of Copland, such as the emulator and PCI (Peripheral Component Interconnect) expansion-board drivers, will be field-tested in staged phases of the Mac OS releases.

In the inevitable comparison to Windows 95, we have to say that Copland is better. It offers Windows 95 services while still providing better features. Some of these features, such as network support through Open Transport and the use of Open Firmware to implement plug and play for expansion cards, are based on industry standards.

Furthermore, Copland offers hardware abstraction, a feature currently found only in Windows NT. This capability will help foster a growing clone market without incurring the compatibility nightmare of supporting diverse hardware—a problem that delays the release of Windows 95.

While these are important technical issues, there's also the issue of the user who'll be sitting in front of the machine. Copland's scalable UI ensures that experts and novices alike can use a Mac to their best advantage. ■

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Cash on the Wirehead

ANDREW SINGLETON



DAVE JONASON © 1995

Traditional forms of payment—barter, currency, and signed checks and vouchers—simply don't work in cyberspace. Making payment possible across the Internet—and the WWW (World Wide Web) in particular—is the goal of a new breed of electronic payment systems that are just now coming into use.

This article examines six of these commercial Internet payment systems and describes their strengths and weaknesses. Each is quite different from the others, and each is appropriate for certain types of applications but ill-suited for others.

You can't do business on the Internet if you can't pay your bills or get paid. Here's how.

Debit and Credit

All systems for making payments—digital or otherwise—fall into one of two different classes: debit and credit. In a debit system, you gather your money up front and then spend it. In a credit system, you spend the money first and pay the bill later. Payment systems based on gold, paper currency, traveler's checks, and instant-debit ATM (automatic teller machine) cards are debit systems. Checks, charge accounts, and credit cards are credit systems.

Just as cash and credit coexist in today's business climate, both exist in the digital world as well. *Digital cash* is the digital equivalent of a cashier's check or a bearer bond (i.e., a token or note issued and signed by a bank or other institution with its name, a random and unique identifying note number, and the amount of money represented). Users can buy these notes from a bank (which makes this a debit system) and then redeem them later for real cash. Although users can make digital copies of such notes, a bank redeems each note number only once.

Digital credit is similar to the credit systems used in the business world. The main difference lies in the incorporation of digital time stamps and signatures that build auditability and accountability into the system and replace the paper trail that's no longer there.

With such a system, the payer creates a voucher record that contains a description of the transaction, the names of the payer and the recipient, the date and time of the transaction, and the amount to be paid. The payer signs this voucher with his or her private key. Using a public key, the recipient of a voucher can read the record and verify that it was signed and obliged by the possessor of that private key. The recipient can then submit the voucher to a clearing system and have legal grounds for collecting payment.

An Infrastructure in Place

The infrastructure for electronic-payment systems already exists: the major credit-card processors (e.g., American Express, MasterCard, Visa, and Discover), ATM networks, and the ACH (Automated Clearing House). Credit-card business involves a three-part processing system. Banks provide credit and billing

The Outlook for Digital-Cash Systems

Given the variety of approaches in the six systems examined here, network merchants have a lot of payment-service options. Which ones will thrive—or even survive? Here are a few predictions.

- Servers will accept a variety of payment methods. (Translation: They'll take your money any way they can get it.)
- WWW browsers with built in public-key signatures will be used. Encryption and digital signatures are needed, but dedicated payment software has a firewall problem. There will be a steady increase in password-capturing software.
- Credit-card companies will begin using network payments in a big way. Their operations are global, and they already have you signed up. These companies will eventually offer corporate billing and debit transactions, as well as consumer credit billing. Right now, they're just biding their time, hoping to get their systems right the first time.
- Digital-cash rollouts will be slow. A major security flaw in many digital-cash schemes, including E-cash, is that somebody who embezzles a bank's private key can create counterfeit cash. The cost of this would probably be borne by the bank. Of course, this prospect makes banks extremely wary.
- It will be quite a while before payment services make money. At a 1 percent margin after clearing, BYTE estimates that each service will have to process $200 million per year—far more than the total volume for 1994—to support a data center and customer-service operation.
- Time-sharing will make a comeback. Why bother to buy, install, and maintain a complex application when you can just attach and go? Rent, don't buy; do it from your laptop. Payment services will support an explosion in creative new information services.

to the customers. Third-party processors provide verification and collection mechanisms for merchants who accept credit cards. And international networks, such as Visa, connect the processors with the banks for collection. This system is complex, but it's already in place and extends nearly everywhere. Charges to merchants typically run 2 percent to 3 percent of the total transactions made, plus 20 cents per transaction.

Several credit-card processors intend to offer their services to merchants on the Internet. The credit-card system is truly international, able to accommodate transactions in a wide variety of currencies and reconcile them in the banking system. This gives it a big advantage on the Internet.

The ACH is a U.S. interbank mechanism in which local banks submit payments to a database and the Federal Reserve transfers the money overnight. This is the manner in which direct-deposit payroll works. ACH transactions are inexpensive (less than 15 cents each) and can be generated by a computer. They will become popular for clearing on-line payments, although ACH works only between U.S. bank accounts.

Debit-card networks allow an ATM to instantaneously deduct money from your account and transfer it to another bank as payment. The banks pay 50 cents per transaction for this. Banks require both a physical card and a password (known as a PIN) before issuing payment. When the obvious existing security issues are resolved, these same networks will have the ability to issue on-line payments.

Nothing prevents private citizens and corporations from maintaining accounts for their customers and issuing payments from those accounts. Most on-line services pay their content providers in this way, and it may evolve into a significant banking role as these institutions offer payment servers for their accounts.

The Mechanics of Payment Systems

An on-line payment transaction generally involves three parties. The *customer* pays, the *merchant* receives the payment, and a *bank* does the accounting, making sure that money from the customer ends up in the merchant's account. In a peer-to-peer system, users can act as both customers and merchants. For the purposes of this discussion, a payment service can act like a bank even if it's not legally considered to be one.



The customer runs *client software*. This might be a WWW browser, such as Mosaic; an encrypting browser, such as Netscape or Mosaic with S-HTTP (Secure Hypertext Transport Protocol); or a dedicated payment client.

The merchant runs *merchant software* on its server to request and process payments. In many cases, the merchant software is integrated with a WWW server. A *payment server* is the bank's POP (point of presence) on the network. To execute a real-time transaction, the merchant generally forwards information to the payment server, which authorizes the payment and credits the merchant's account.

Security and Privacy

Security issues are critically important in any digital-payment mechanism. The most common way to authenticate a user is to ask for a password. Because it's easy to read messages as they traverse the Internet, most commercial services encrypt passwords before sending them, using the new generation of WWW browsers. These include Netscape (which uses SSL [Secure Sockets Layer] encrypted protocol) and Mosaic derivatives (which use S-HTTP).

Unfortunately, even encrypted passwords aren't secure if they are used more than once. Ultimately users may be forced to rely on the use of *hardware tokens*—typically, credit-card-size devices that can generate unique one-time passwords or securely maintain encryption keys.

To ensure security, financial messages—whether they're payments, credit-card numbers, or digital signatures—must remain confidential and be impossible to alter without detection. Most systems currently in use maintain some kind of paper trail that can be used to check and audit transactions; equivalent capabilities must be a part of any viable on-line payment system. Current cryptographic mechanisms can provide these features.

Privacy is a related but more controversial issue. In this age of mammoth databanks, many people think that it's time to draw the line. Some believe that digital financial transactions should be, in principle, just as anonymous as cash transactions and that it's nobody's business—certainly not the merchant's, the bank's, or the government's—where people spend their money. This goal can be achieved with existing digital cryptographic technologies, but only some electronic-payment systems currently make use of them.

The Internet's First Payment Systems

BYTE recently surveyed six different commercial systems from Cybercash, Digicash, First Data/Netscape, First Virtual, Open Market, and Wave Systems. This list does not include what may well become the two biggest guns on the payment-services battlefield—the joint

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COMPUTER ASSOCIATES
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ventures announced by Visa/Microsoft and MasterCard/Netscape. Neither is due to be available until late this year, and neither is well defined at present. But the six services examined here are close enough to real-world deployment that a realistic evaluation of their implementations and prospects is possible. The fundamental features of each system and details on how it works are summarized in the table "Digital-Cash Systems Compared" on pages 76 through 78.

Cybercash

Cybercash proclaims that "the bank is our customer" and anticipates that all its transactions will be passed directly to a real bank. Thus, customers will talk to the bank, not to Cybercash, for customer service. As this article was being written, Cybercash had scheduled a pilot project with Wells Fargo Bank for March, with service available to the public in May.

Cybercash software should work well as a bank interface by providing a portable ATM for home banking. The debit version could prove to be an excellent mechanism for funds transfer, bill paying, and peer-to-peer payments. But the initial credit-card version is less appealing. The customer must enter a credit-card slip for each transaction, and there's no mechanism for subscriptions. With Cybercash, as with credit cards, merchants are liable for fraudulent transactions. BYTE rates Cybercash as fair to good for one-time catalog sales, but only fair for information sales.

Digicash Ensures Privacy

Digicash is the most radical—and possibly the most significant—player in the payment-services game. Founder David Chaum has invented and patented a form of digital cash, called *E-cash*, that offers privacy for the buyer. Says Chaum, "When all payments are recorded electronically, the notion that an electronic payment system doesn't have to invade your privacy will be very important, almost a human right."



The E-cash software is convenient and fun to use. As a peer-to-peer payment mechanism that allows individuals to exchange payment with anyone anywhere on the globe, without paying high fees or giving up privacy, E-cash empowers the individual. It sounds great, and BYTE believes it could work.

Because no banks have yet signed on to the E-cash system, it's difficult to evaluate its suitability. Close attention will certainly be paid to its progress. The software is currently being tested with play-money cyberbucks.

First Data/Netscape: Business as Usual

First Data, the biggest U.S. credit-card processor, and Netscape Communications, one of the hottest commercial vendors of WWW software, have teamed up to offer credit-card authorization. The mechanism is actually a minimum modification to the phone-based credit-card payment systems now in use. Instead of calling in a credit-card number to a merchant, a customer types the number onto an HTML (Hypertext Markup Language) form, and the client takes advantage of Netscape's built-in encryption to send it to the merchant server. The product is currently in use at Marketplace MCI. Both the Netscape server and the First Data processing service are first class, but the union of these two organizations does not add much value.

Also, the product's requirement of a dedicated phone line adds significant expense. Merchants with encrypting Netscape or S-HTTP WWW servers can install inexpensive card-authorization software, such as IC-Verify, for less than $500 and work with the credit-card processor of their choice. Moreover, users already send their card numbers to merchants. And, while simple, this product's mechanism inherits all the security flaws of the current credit-card payment system. It's clearly an interim product, and thus BYTE rates its suitability as only fair.

Merchants and customers should instead look forward to Netscape's venture with MasterCard, in which MasterCard will place a payment server on the Internet. This will eliminate the merchant's need for a dedicated phone line. Also, a payment server on the Internet will increase security for customers, since signed credit-card slips will go directly to the payment server for authorization without revealing customer information to the merchant.

First Virtual: Try Before You Buy

First Virtual is a unique credit-card processor because of its try-before-you-buy approach. The system, already in operation, is designed primarily for vendors selling information and other "soft" goods. The *Virtual* in the name refers to a unique company organization: The principals all work in different states, and the phone-response and Internet-server maintenance are contracted out to companies in yet other states. Company principals claim that the virtual organization and its simple, voluntary payment system are well suited to the decentralized culture of the Internet.

The First Virtual service is a simple way for a merchant to process credit-card transactions. It requires no special WWW browser, infrastructure, or merchant processing account. And the merchant start-up fee is only $10.

Unfortunately, the system, with all its passwords and insistent E-mail, is also somewhat inconvenient for the customer to use. The payment schedule is uncertain, the sign-up mechanism is automated and clunky, and the "virtual" concept doesn't seem to support a real service organization. For suitability to WWW information sales, BYTE rates First Virtual as fair.

Open Market: Full Service on the Web



Open Market is a start-up company dedicated to building Internet stores and the payment services to support them. Its system is entirely WWW based and exploits the HTTP standard to its fullest. The system is currently in operation for internal use by the Open Marketplace WWW servers.

Unlike some other providers examined here, Open Market views itself as a service company that's willing to handle customer accounting and billing as well as development. Open Market's is the only payment server to provide customer service, subscription accounting, charge aggregation, scalable security, and business-to-business accounting.

The implementation is clever and convenient, with the downside being that the

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DIGITAL-CASH SYSTEMS COMPARED

	CYBERCASH	DIGICASH
Credit- or debit-based?	Credit-based now; debit is planned.	Debit.
Customer software	Cybercash plans to distribute free client software with which the user can transmit credit-card charge slips and debit authorizations and view some account information. Typically, a Cybercash client runs on the same workstation as a WWW browser.	Digicash is a peer-to-peer system, so merchants and customers can use the same client software that Digicash distributes for free.
Merchant software	The merchant receives a free software library to build and parse Cybercash messages. The merchant's Internet server calls this library to request payment.	Most merchants need the text-based version of the software so that they can integrate it into their Internet servers.
How customer pays	The initial Cybercash implementation supports only credit-card payments. The customer types a credit-card number into a charge slip that pops up in the Cybercash window; this charge slip is forwarded to the merchant's credit-card processor. Cybercash also intends to support debit and peer-to-peer transactions through Cybercash accounts.	The customer buys E-cash from a participating bank. The customer can pay with an account transfer or with E-cash received from other customers. The E-cash client keeps files of encrypted digital-cash tokens (called "coins") and provides a graphical interface that allows the client to buy, send, and receive money and review the transaction log.
How merchant is paid	With credit-card transactions, the merchant gets paid by a participating credit-card processor. With debit transactions, money appears in the merchant's Cybercash account after a one-day clearing period.	The merchant calls the client software over the Internet (technically, the client acts as a server) and asks for payment. The merchant redeems each E-cash token with a payment server at the issuing bank, which transfers money to the merchant's account. All payments are final; the merchant need not budget for challenges.
How a transaction is handled	The customer connects with a participating merchant via a WWW browser. When the customer presses the RPAYS button on a form, the merchant server sends a message that invokes the Cybercash software and asks for money. A window pops up, asking the customer to either authorize a debit transaction or fill out a credit-card form. The client software signs and encrypts the form and sends it to the payment server. The payment server forwards the information to the merchant's credit-card processor (for credit) or to the customer's bank (for debit) for authorization. The payment server signs and encrypts an authorization token and sends it back to the customer's client software, which sends it back to the merchant.	The customer buys E-cash coins for his or her digital wallet and then starts a WWW browser or other Internet software. When a merchant wants payment from the customer, the merchant's server sends a payment request to the client software. The E-cash client software pops up, the customer approves the payment, and the client software sends E-cash coins to the merchant. The merchant then connects with the bank payment server and sends the coins to the bank. The bank checks the note numbers and signature, redeems them by transferring money to the merchant, and sends back a verification message. It's possible for the E-cash client software, running in a tiny window, to have a policy to authorize transactions automatically.
Support for small micropayments	Cybercash intends to support large transactions for both hard goods and bill payments, as well as debit micropayments for small units of information.	Yes.
Accounting services or capabilities	None. All authentication, subscription accounting, and cumulative billing must take place on the merchant's server. Cybercash only clears the eventual payments.	Digicash provides no accounting. By collecting receipts, and possibly by auditing the redemption of notes, however, a business can impose accountability on E-cash.
Cost per transaction	Cybercash charges a fixed fee per transaction, with no percentage add-on. For credit-card authorization, the charge is 5 cents, to which the credit-card processor adds its customary fee, often 2 percent plus 20 cents. The Cybercash charge for a debit transaction is 30 cents, with no processing fee. The company intends to bring down the cost of Cybercash debit transactions.	Digicash is a development company, not a payment-services company. It will charge the banks that sell E-cash some type of licensing fee, although details are still unknown. Customers and merchants will pay a transaction fee to the bank. As a pure debit system with no collection problems, E-cash should be noticeably less expensive than credit-card clearing.
Risks to merchant and customer	Cybercash accounts earn no interest and cost the customer float. Under "card-not-present" rules (similar to those for telephone sales), the merchant is liable for fraudulent credit-card transactions. There is currently no mechanism for handling disputed debit transactions, so presumably the customer assumes all the risk with those.	Lost or stolen E-cash can't be recovered, nor can payments to unscrupulous merchants. Because a note is untraceable, all notes in circulation must be voided if the issuer's key is embezzled. The customer gets a signed receipt from the merchant, but payment is final and cannot be reversed if the merchant fails to deliver. The customer loses the float with E-cash.
Security and privacy	The client software includes RSA public-key encryption; the user unlocks the private key with a password when the software starts up. The customer's bank receives detailed information on each transaction, but a customer can remain anonymous to the merchant except for IP address. The Cybercash client can be installed as a viewer in the WWW browser; in the future, this will allow the merchant to request money through a firewall. The client will also use HTTP proxy services to communicate across a firewall.	A customer can remain anonymous to the merchant except for IP address. A client creates notes with a random note number and an amount, and a bank signs them. When a bank gets a note for redemption, it checks for a valid signature and an unredeemed note number. Neither the bank nor the merchant knows who bought a particular note, but the customer can go to the bank and find out who redeemed the notes. This is known as one-way HTTP privacy. The current technique doesn't work through firewalls. Digicash plans to offer its own proxy software.
Special hardware	None.	None.
Suitability for applications	Well suited for home banking and catalog sales. Poorly suited for WWW information sales.	Target market is information sales. E-cash is efficient for small transactions and is well suited for transferring funds. Governments have valid concerns about the use of E-cash for money laundering, gambling, and other prohibited activities.
Problems	A customer must enter a credit-card slip for every transaction and forgo the benefits of subscriptions and cumulative billing.	No bank has yet stepped forward to sell E-cash.

OPEN MARKET	WAVE METER
Credit.	Debit.
The Open Market payment server works with any WWW browser.	Requires dedicated software for browsing Wave-encrypted information. The software uses the Wave Meter API to perform decryption and metering appropriate for the application.
The merchant integrates functions from Open Market into its WWW server. These functions create payment URLs (uniform resource locators) for forwarding to the payment server. Open Market also sells its own S-HTTP server, which works with its payment server.	The merchant designs custom applications software using the Wave API.
Currently, the customer must pay with a credit card. Open Market intends to support direct corporate billing as well.	Customers "buy" money in advance by starting a communications program and entering credit-card information. The communications program calls Wave Systems and downloads credits to the Wave Meter chip.
The ACH (Automated Clearing House) transfers payment to the merchant's account.	When a customer calls up Wave Systems to get more credit, the Wave Meter chip downloads usage information, and Wave Systems pays the merchant.
A transaction begins when the merchant server sends the customer an HTML (Hypertext Markup Language) document containing a button with a payment URL. This URL contains the payment server's address, an item description, the merchant's name, the price, and a secret key signature. When the user presses the button to invoke the payment URL, it goes to the payment server rather than to the merchant. The payment server then begins an authentication dialogue with the customer. When the payment server finishes authorizing the transaction, the server issues a redirect to the customer's browser, instructing it to contact the merchant server with an authorization URL. The merchant server then releases the product.	When the customer wants to use a particular item, the browsing software performs a transaction with the Wave Meter, which retrieves a secret key and subtracts money from the credit accumulator. The processes of charging and decrypting can be hidden from the user.
The Open Market server will aggregate small transactions into $35 credit-card charges, making it suitable for low-value information sales.	There is no per-transaction charge, so the Wave Meter is suitable for small-valued transactions.
The Open Market payment server intends to offer authentication, subscription verification, and the purchase and verification of temporary subscriptions. Open Market intends to offer business-to-business direct billing in the future.	The Wave Meter has counters and clocks for subscriptions and can meter software rentals. A planned Novell NetWare server–based product will consolidate bills for all LAN users, with individual credit limits and client bill-back codes. This will be especially useful in law firms.
Merchant costs are 3 percent plus 20 cents per transaction, plus setup fees.	Wave Systems charges the merchant a negotiable rate, currently 20 percent to 40 percent of the total revenue.
The merchant assumes the risk of fraud.	The customer "buys" money in advance and loses the float. Losses are borne by both the customer and the merchant. If a machine goes out of service before the customer uses up the credit in the Wave Meter, the customer loses. If the customer stops using the service or the machine, or if communications fail, the merchant loses the revenue to Wave Systems.
Asks for passwords and other information, so an encrypting browser is recommended. Open Market currently supports S-HTTP encrypting browsers. Open Market receives detailed information on each transaction, but a customer can remain anonymous to the merchant except for IP address.	Wave Systems keeps a detailed record of all transactions. This information can be distributed to the merchant.
None.	A Wave Meter must be installed on a local machine or on a local Novell NetWare network.
The system is intended for sales of both hard and soft goods.	Target market is pay-per-use information distribution via encrypted CD-ROM, satellite or FM broadcast, and daily downloads. Also suitable for software distribution; enterprise licensing; and pay-per-play, CD-based games.
The user must interact with the payment server on every transaction.	Expensive, complex, and not competitive with central payment servers.

DIGITAL-CASH SYSTEMS COMPARED

	FIRST DATA/NETSCAPE	FIRST VIRTUAL
Credit- or debit-based?	Credit.	Credit.
Customer software	The customer must have the encrypting Netscape WWW browser, which is free for noncommercial distribution and $39 per copy for commercial use.	No special software is required. Interested parties can use any WWW browser and E-mail reader with First Virtual. To sign up for an account, users call an automated telephone center that takes their credit-card information.
Merchant software	Merchants must have the encrypting Netscape Commerce Server ($5000) and First Data interface software. With the current implementation, the merchant must run a dedicated phone line to First Data's processing center, which costs several hundred dollars per month.	The merchant must integrate a set of free communications routines with its server.
How customer pays	A credit-card charge is assessed for each transaction.	The customer can pay via credit card or via ACH transactions, which are authorized when a voided check is sent in.
How merchant is paid	The merchant gets a normal bank transfer from First Data.	The merchant gets paid via an ACH transfer to its bank account.
How a transaction is handled	The merchant makes up an HTML form that contains information about the transaction. The customer enters a credit-card number on the form and returns it to the merchant's server with Netscape's built-in encryption. A script running on the merchant's server forwards the credit-card information (as a standard authorization transaction) over a dedicated phone line to First Data's credit-card-processing center. When the charge is authorized, the rest of the transaction proceeds.	The merchant initiates a transaction by displaying a WWW form that asks the customer for his or her unencrypted, unsecured password. The merchant software forwards the password and a description of the transaction to the First Virtual payment server. The customer then receives E-mail from First Virtual asking for authorization. The customer can reply with Yes, No, or Fraud. If the client replies No, he or she isn't billed, but a high percentage of No responses gets the customer kicked off the service as a freeloader. If the customer replies Fraud, he or she does not get billed. However, his or her account is then deactivated, and he or she must call to obtain a new password.
Support for small micropayments	No.	No.
Accounting services or capabilities	Additional modules in the Netscape server, which are announced but not yet available, should provide subscription accounting and billing.	None.
Cost per transaction	Costs are identical to the merchant's existing card-not-present processing fees.	First Virtual charges the merchant 2 percent plus 29 cents per transaction.
Risks to merchant and customer	The merchant assumes all risk.	The merchant assumes all risk. For this reason, First Virtual suggests that the service is most suitable for information sales, where the cost of distributing nonpaid products is negligible.
Security and privacy	Uses secure HTTP with Netscape. The Netscape server provides password-based access restrictions. There is no privacy; the merchant receives all the customer's purchase and credit-card information.	First Virtual receives detailed information on each transaction, but the customer can remain anonymous to the merchant except for his or her IP address.
Special hardware	None.	None.
Suitability for applications	Well suited for catalog and subscription sales.	Target market is sales of software, low- to moderately priced information, and information subscriptions.
Problems	Poor security for users; expensive for merchants.	The payment schedule is uncertain, the sign-up mechanism is automated and clunky, and the "virtual" concept doesn't seem to support a real service organization.

customer must interact with the payment server on every transaction. BYTE rates this product's suitability as good.

Wave Systems: Like a Vending Machine

Wave Systems' Wave Meter, now in beta testing, represents a totally different, hardware-based approach to digital cash. It includes a chip that you install in your computer. You download money to the chip, which then meters it out as you spend it.

Wave Systems, a five-year-old public company, was founded by Peter Sprague, chairman of chip maker National Semiconductor. According to Sprague, "we follow the vending-machine model." The Wave Meter can be used to sell information, software licenses, or software time.

The Wave Meter is also good for metering and unlocking information that arrives on encrypted one-way media, such as CD-ROM and satellite or FM broadcast. But the complex Wave Meter system is not competitive with central payment servers, and therefore BYTE rates its prospects and usefulness as poor.

Winners and Losers

These six systems take a wide variety of approaches. As mentioned earlier, each has applications where it's especially well suited, but each also has its limitations and may not work so well for other purposes.

Furthermore, these digital-cash systems are quite literally in their infancy. None has enough of a track record to guarantee its future. And we have yet to see what some of the important players, including the major credit-card organizations, plan to do. Finally, the evolving nature of commerce on the Internet also means that a system that works now may become impractical next year.

These are all serious obstacles that digital-cash systems must overcome. But we can be certain that good solutions will indeed appear. After all, the cyberspace community needs to get on with business. ■

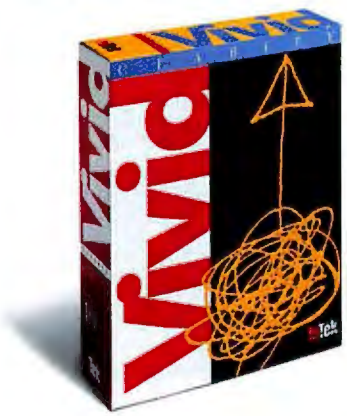
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PETER D. VARHOL



Tired of hard-wiring Windows for multiple processes? Photon lives for event-driven applications for PDAs, process control, and data acquisition.

A friend of mine is searching in vain for the Zen of Windows. He seeks a way to magically fit together all the individual and often disjointed pieces of Windows programming into a coherent whole. This enlightened programming model would yield an intuitive feel for Windows applications design. APIs would be simple details that you look up as you need them.

His search has been futile because the Windows programming model is fundamentally incoherent. He'd have far more luck if he turned his attention to Photon, the new windowing environment for QNX, where coherence is as natural as the air on Mt. Fuji.

Photon gives developers a great deal of control over how processes respond to events. Best of all, this control is built into the architecture rather than being something that a developer must add, as in Windows. The Photon windowing model depicts processes and events that programmers must take into account when developing applications for a windowing system (see the text box "The Photon Architecture" on page 84). This type of control is important for specialized applications ranging from a handwriting-recognition program for PDAs (personal digital assistants) to applications for data acquisition and process control devices.

Photon is an optional module for QNX, a Posix-compliant real-time OS (see "QNX Forges Ahead," October 1994 BYTE). In about 650 lines of code, the 10-KB QNX microkernel performs IPC (interprocess communications) locally and over a network, process scheduling, and interrupt redirection. You need only about 14 system calls to access these services. QNX is a message-passing OS that doesn't distinguish between local and remote messages. This is one feature that makes it an excellent distributed OS.

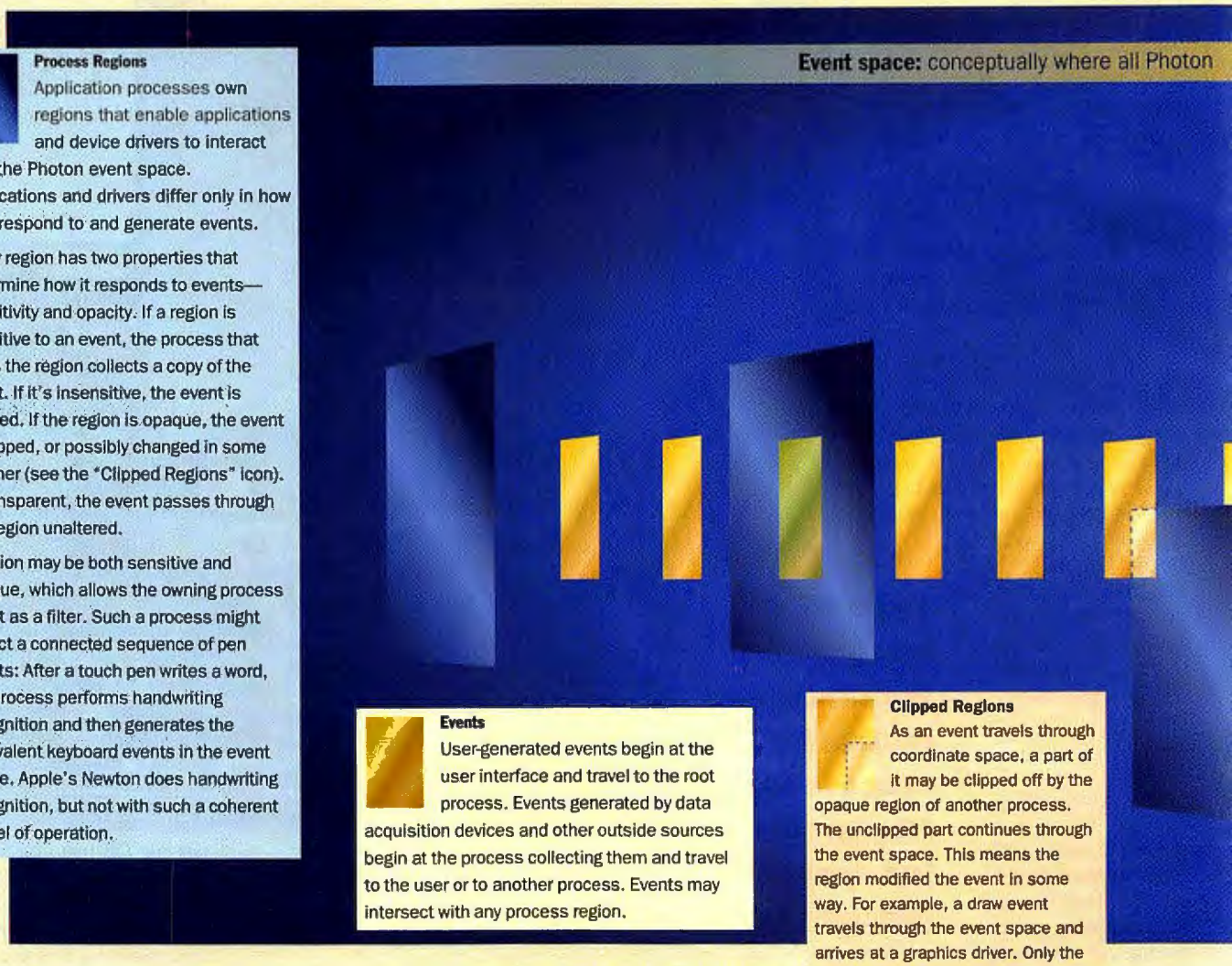
Photon is built on these same principles. The Photon microkernel is a resource manager that creates a graphical event space and manages regions and events in that space. The Photon microkernel is about 24 KB of code plus 40 KB of data. Extra components, such as shared libraries and drivers, might increase the amount of code and data to about 250 KB. The Photon Window Manager adds 24 KB of code and 48 KB of data.

In addition to Photon, QNX offers as an option a full X11R5 implementation of the X Window System, with the Motif window manager, scalable fonts, and font server. X uses the QNX message passing for communication between QNX kernels and uses TCP/IP for communication with other X servers.)

QNX runs its device drivers as user processes, which means you can dynamically load drivers when you need them. For example,

The Photon Architecture

Photon is not just another GUI. It is an event-driven system that waits for the user (or sometimes the system) to send a signal; it then redirects the signal to the appropriate process or processes. Photon developers control whether and how various processes respond to the same events. This control is a characteristic of Photon's architecture rather than being something that a developer must add. The Photon microkernel is also compact: about 24 KB of code plus 40 KB of data.



Process Regions
Application processes own regions that enable applications and device drivers to interact with the Photon event space. Applications and drivers differ only in how they respond to and generate events.

Every region has two properties that determine how it responds to events—sensitivity and opacity. If a region is sensitive to an event, the process that owns the region collects a copy of the event. If it's insensitive, the event is ignored. If the region is opaque, the event is clipped, or possibly changed in some manner (see the "Clipped Regions" icon). If transparent, the event passes through the region unaltered.

A region may be both sensitive and opaque, which allows the owning process to act as a filter. Such a process might collect a connected sequence of pen events: After a touch pen writes a word, the process performs handwriting recognition and then generates the equivalent keyboard events in the event space. Apple's Newton does handwriting recognition, but not with such a coherent model of operation.

Events
User-generated events begin at the user interface and travel to the root process. Events generated by data acquisition devices and other outside sources begin at the process collecting them and travel to the user or to another process. Events may intersect with any process region.

Clipped Regions
As an event travels through coordinate space, a part of it may be clipped off by the opaque region of another process. The unclipped part continues through the event space. This means the region modified the event in some way. For example, a draw event travels through the event space and arrives at a graphics driver. Only the unclipped portion of the event will be drawn on screen.

Why the Photon Programming Model Is Important

It makes windowing programming and windowing behavior more consistent by depicting the behavior of processes and events important to programmers. By contrast, the Microsoft Windows programming model is less coherent. A process (each individual window) doesn't normally receive an event unless it's the active process (the one closest to the user). If you want other processes (other windows in the same application) to respond to events, Windows requires you to find a way to do this. The active window may collect an event and then pass it on to other windows, like prospectors panning for gold. If the first prospector (the process) finds a gold nugget, he or she keeps it; if it is fool's gold, he or she throws it back into the stream for the next prospector. Implemented in a process-by-process manner in Windows, this type of solution is natural behavior in Photon.

Event control like this is important for a handwriting-recognition program in a PDA or for data-acquisition and process-control applications. For example, you might want a user-initiated event to change the visual image of an instrument control and also have that event let a process-control driver send a signal to an electronic control.



Device Drivers
These are the enablers of events in Photon. Mouse and keyboard drivers are input drivers; the graphics driver is an output driver. Device drivers run as user programs, which makes it possible to dynamically load drivers when you require them. You can have multiple drivers running in the same coordinate space. For example, multiple graphics drivers can display different portions of the visual output on different screens or even screens on other computers on a network. With Photon, you could drag an application from the screen of a desktop computer to the screen of a PDA.

Programmer's Notes

Programming for Photon centers on initially positioning a region, telling the Photon microkernel which types of events are relevant to the region and then dispatching based on the event received. Photon consists of a single X Window System–like API. The API may consist of four separate libraries: graphics; a Photon Window Manager, which is optional; AppBuilder, a visual C-code application development environment; and widget, the user-interface component. The windows manager can automatically control windows and regions created by applications. The window manager creates icons, and resizes and repositions process regions within event space.

Photon and X may require a mouse driver, and X may need to access a CD-ROM drive. To load these, you simply type `Mouse msoft </dev/ser1` for a Microsoft serial mouse, and `Fsys.Aha4scsi` for an Adaptec-compatible SCSI CD-ROM drive. The drivers load into user space, find the devices, and make them available to the system. Running drivers in the user space provides MMU (memory management unit) protection for user processes. Also, you can use a full screen source code debugger to debug device drivers. You might think that running device drivers in user space causes unacceptable performance penalties, but we haven't noticed any problems with the QNX applications we have built.

Photon is remarkably easy to install for a Unix-like product. We just loaded the requisite drivers from the command line, called the install program on the floppy or CD-ROM drive, and launched the program. Because QNX runs everything as a process, we only had to rebuild the kernel when we upgraded the base OS.

How easy is Photon to use? The first time we used Photon, its application-builder module wouldn't launch. But after taking a quick trip through the Photon documentation, we discovered that we had to run Photon in Super VGA mode. We then simply returned to the QNX command line, ran the Super VGA driver, and returned to Photon.

Windows for the Masses

If programmers use the Photon model depicted at left, there should be no question about the behavior of their process in response to events. Furthermore, programming becomes more straightforward because the model is consistent and easily extensible without much effort. Our experience with Photon backs that up: We wrote a resource-scheduling application in only about 100 lines of code.

While it is natural to compare Photon to a general-purpose windowing system like Windows, the comparison may be a poor one. Photon is not designed for general-purpose use, and it has fewer APIs than Windows or other known systems. The Photon event model may not be widely usable in general-purpose computing. Imagine a transparent process that automatically passes mouse-clicks through to other applications. Without controlling or even knowing about the behavior of all running applications, such a process can wreak havoc.

Photon is designed for an application environment that is more controlled than a Windows application environment. A Photon programmer of one process should know

Get That Data

Photon can be useful for real-time display of data in data acquisition applications and for process control. Using the AppBuilder visual-application designer, you can write an application that intercepts events coming in asynchronously and displays them graphically in any desirable fashion.

Because the default QNX scheduler lets you schedule real-time events, data acquisition can be real time. (If you don't like the default scheduler, you can write your own—it runs in user space). Photon is capable of updating the display faster than the display's refresh rate. This is a waste of CPU cycles, because it has to wait for the display to update before you can see any changes. Thus, it makes sense to constrain Photon data acquisition events to correspond to the display refresh rate (e.g., 72 Hz).

Process control can work in reverse. As data comes in and is displayed, events can be generated in the other direction. You can generate a touchscreen or light-pen pointer event, to which a control process is opaque. The control process translates the light-pen event into an appropriate control signal, which Photon then transmits out through a port to an instrument that can respond to it.



what other processes are running under the windowing system. Therefore, events for one process will not be mistakenly intercepted by others.

But the behavior of processes in Photon defaults to the opaque value of the opacity property (see the "Process Region" icon on page 84), so under normal circumstances, it behaves like Windows or X (Photon defaults to Motif window manager).

If you want to do something unusual, you have to adjust the properties of the processes. For example, in a process control application, you might want a series of different processes to simultaneously receive the same mouse-click signal. In this instance, you probably don't also want to run Photon as a general-purpose windowing system.

Photon need not run on the same system as its processes. Some developers are even running Photon under Windows on separate systems simply by passing process events to and from the Photon manager, which runs as a Windows process.

Photon uses a coherent model of process interaction in an event-driven environment. If your benchmark is Windows or a general-purpose windowing system, you can appreciate QNX and Photon as being small and elegant operating environments for process-control and real-time systems. As Photon develops, we may see it appear on more desktops as an alternative windowing system. ■

Product Information

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Photon $95
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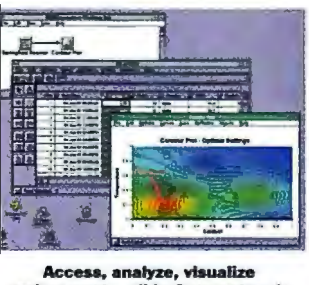
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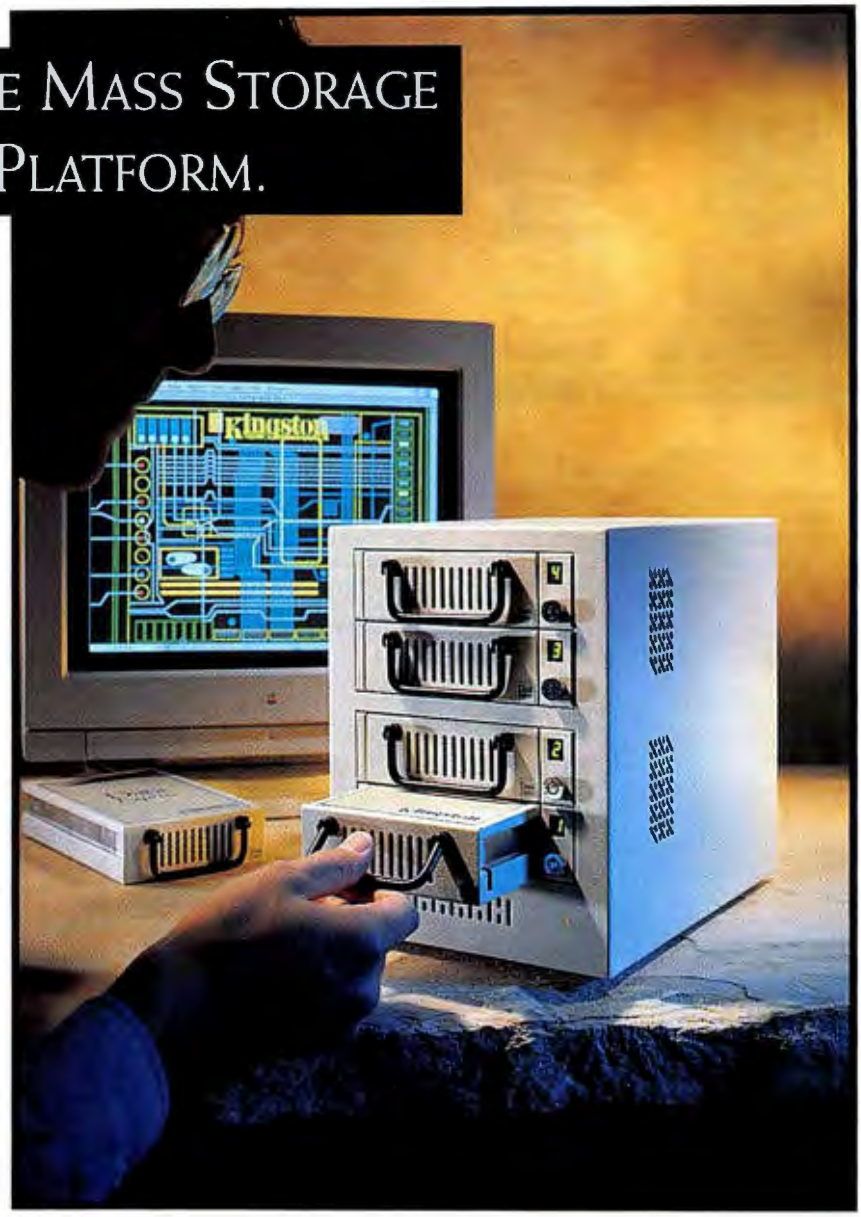
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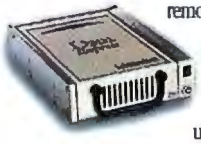
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Break Up Your Network

BRETT HUSSELBAUGH



By dividing your network into smaller, interconnected segments, you can increase throughput by reducing competition

Your network is probably considerably less efficient than it could be. Dividing it into smaller subnets can significantly enhance performance in most cases. Segmentation is one of the most important but least understood aspects of a highly tuned network.

To segment a network is to divide it into two or more physically independent *competition domains*. Consider the figure "Network Segmentation" on page 92 which shows a token-ring network before and after segmentation. In its original, single-domain configuration, all seven nodes had to compete for the single token serving the network.

Now look what happens when the network is segmented into three separate competition domains, or rings—one for the server, one for three workstations, and one for the other three workstations. After segmentation, the worst-case scenario is three workstations competing for a token, and there are three tokens serving the network. Of course, you have to add an extra piece of equipment—the bridge that connects the three rings. Network segmentation requires one or more internetworking devices, such as a bridge, a packet switch, or a router, to connect the segments into a single logical network.

The Bandwidth Misconception

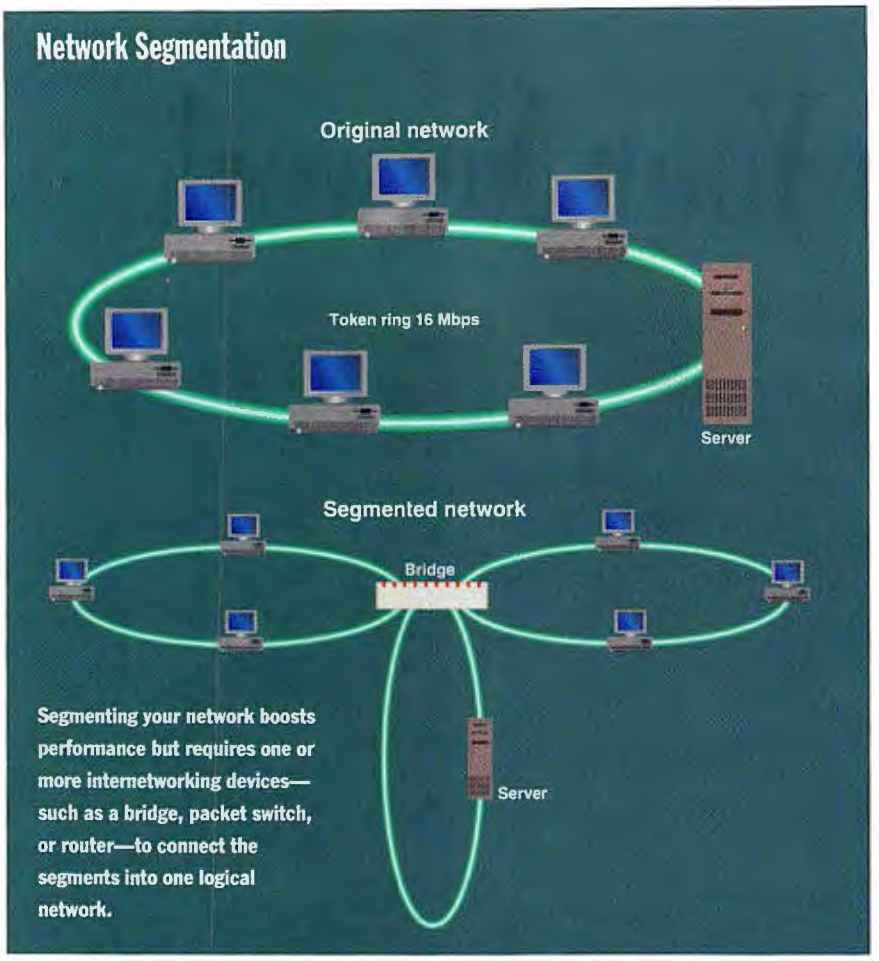
Network performance is most commonly quantified in terms of bandwidth. However, using bandwidth techniques to predict network performance is fraught with inadequacies. (See "Misusing Bandwidth" in the December 1994 BYTE.) One particular problem with bandwidth is its failure to take competition into account.

For example, say you have a new network application that you want to roll out to 40 users, although you don't expect more than 10 to ever be using it simultaneously. Before you install it, however, you want to make sure that the application won't overload the net and bog down total throughput of your 16-Mbps token ring. So the first thing you do is to take a series of measurements with a network analyzer, and it tells you that one workstation will demand an average throughput of 51.2 Kbps. If you're still thinking in terms of bandwidth, you can make the following calculations:

10 simultaneous workstations × 51.2 Kbps = 512 Kbps
512 Kbps × 8 bits per byte = 4.096 Mbps
4.096 Mbps requires only 25 percent of a 16-Mbps bandwidth

Therefore, you conclude that your 16-Mbps token-ring network will comfortably sustain the required traffic. Unfortunately, bandwidth doesn't tell the whole story. Keep this example in mind, and later on we'll compare it to a far more effective method for predicting network performance.

ILLUSTRATION: BOB DOUCET © 1995



Competing for Queue Space

Queuing theory is a branch of mathematics that grew out of telephone traffic studies conducted at the beginning of the twentieth century. It is used extensively to model packet-switched as well as circuit-switched networks. Because it handles the probabilistic nature of communication systems, queuing theory is an effective tool for network analysis.

In its simplest form, a queue is nothing more than a place where things can wait their turn for service. The line at the bank and a network computer's incoming-packet buffer are both examples of queues. A queue will have one or more servers (not to be confused with file servers), which are processes that move items through the queue. One or more tellers, for example, deal with customers in the bank line, and one or more operating-system processes will service the incoming-packet buffer.

We can further describe a queue in terms of two rates—the rate at which new things appear in the queue for service (λ), and the rate at which things are serviced or removed from the queue (μ). As λ exceeds μ—that is, as new items appear faster than they can be serviced—the queue will begin to lengthen. If λ continues to exceed μ, the queue buffer will eventually be filled, and any additional new items presented for service will be rejected.

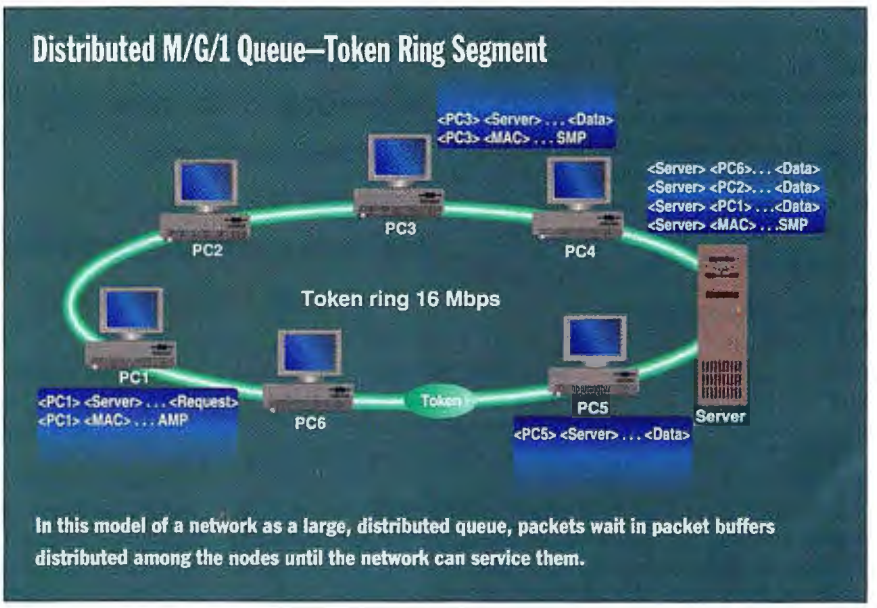
We can model a network as a large, distributed queue. The figure "Distributed M/G/1 Queue—Token-Ring Segment" shows the concept graphically. Packets wait in a number of packet buffers that are distributed among the various active nodes until the network can service them. The queue's server here is the network's access methodology. In the case of a token-ring network, therefore, the queue's server is the token itself.

Competition occurs on a network because, in general, only one node may transmit on the media at any given time. As competition increases, therefore, each node spends more and more time waiting for the token, until we reach a point at which the wait time becomes far greater than the time actually spent transmitting. Using queuing theory, we can quantify the time spent waiting on the media.

Modeling the Network

In analyzing the effects of competition on a segment, we'll focus on token-ring networks. CSMA/CD (Ethernet) performance usually degrades sharply as competition is raised, giving the network administrator highly discernible notice that segmentation is required. Token-ring performance, on the other hand, degrades more gracefully, and it might not be readily apparent that performance can be significantly improved. By modeling token ring as a queuing system, we can study the effects of competition and discover the influence of other parameters, such as packet size. (This example is somewhat simplified. We don't consider either early token release or such windowing methodologies as packet burst.)

We will consider a token-ring segment as a queue model that has the following characteristics: Markov arrival statistics (also called Poisson distributed), generally distributed service times, and a single



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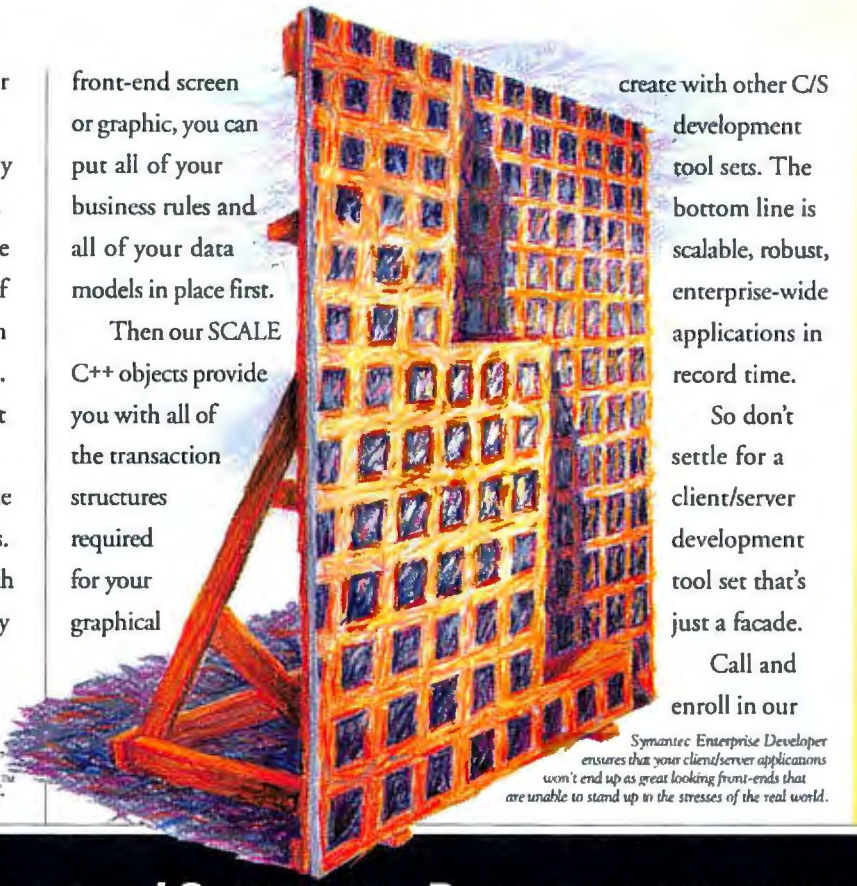
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queue server. (Thus we call this an M/G/1 queue.) Poisson arrival statistics means that packets reach the network from the individual network nodes in a fairly random fashion. Generally distributed service times (as used here) means that, once a packet is granted access, the transmission time follows a uniform statistical distribution. Simply stated, this means that we'll consider that all packets are the same size.

We can determine the wait time in an M/G/1 queue using the following equation, which you'll find in any book on classical queuing theory:

$$E[T] = \frac{1}{\mu - \lambda}\left[1 - \frac{\lambda}{2\mu}(1 - \mu^2\sigma^2)\right]$$

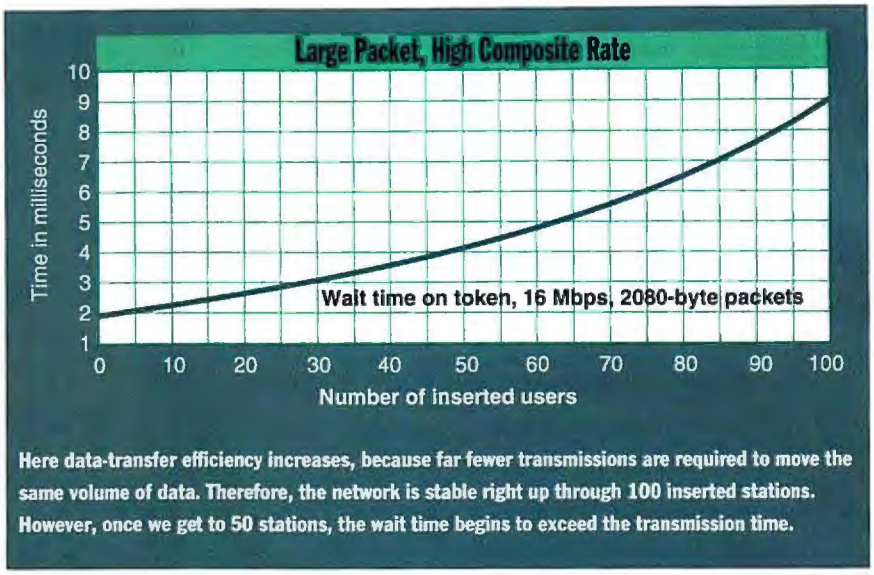
Where
E[T] = average wait time
μ = packet service rate, in packets per second
λ = packet demand rate, in packets per second
σ^2 = variance of packet size distribution

We adapt this equation to the token-ring model by appropriately defining the rate at which packets are generated for transmission on the segment (λ) and the rate at which packets are serviced (μ)—that is, accepted for transmission, transmitted, and the token freed. We define these parameters as follows:

$$\lambda = 2a\lambda_u N_u$$

$$\frac{1}{\mu} = \frac{10N_p}{f_s} + N_u t_d$$

Where
λ_u = source rate per user, in packets per second
N_u = number of inserted users



Here data-transfer efficiency increases, because far fewer transmissions are required to move the same volume of data. Therefore, the network is stable right up through 100 inserted stations. However, once we get to 50 stations, the wait time begins to exceed the transmission time.

a = percentage of inserted users wishing to transmit simultaneously
N_p = average number of bytes per package
f_s = signaling rate in bits per second
t_d = time delay due to inserted station, in seconds

We need the factor of 2 in the equation for λ because, in most client/server environments, every packet from a client must be answered by a packet from the server. Also, the factor of 10 in the equation for μ accounts for the 8 bits per byte, plus an additional 1.25 factor for packet overhead and other node delays in the system.

Applying the Model

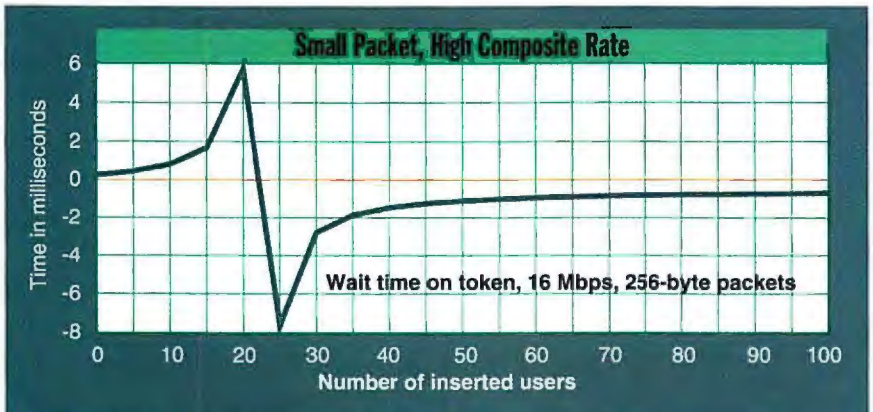
How can these equations help us tune our network? They can tell us how many segments to divide our network into, and how many nodes to put on each segment, based on parameters that fit the needs of a particular network.

The first thing to do is decide what level of packet demand we're interested in, along with a figure (expressed as a percentage of the total) that represents the number of stations actively transmitting on a network segment. We can plug these numbers into the equation and plot the results against the number of inserted stations on the segment.

Let's look at an actual example, shown in the figure "Small Packet, High Composite Rate." This models the same situation as we used earlier in the bandwidth analysis. In this case, we're showing a 512-Kbps throughput demand placed on the network by a composite set of nodes. The packets are uniform in size, but small, at 256 bytes. Notice how the length of time each node must wait for a token builds to roughly 6 ms before going negative at approximately 20 inserted stations. This means each packet spends 47 times as long waiting for the token as it does actually transmitting its data.

And what does it mean when the wait time goes negative on the plot? In fact, it becomes mathematically undefined at that point, which means that the real-world network becomes unstable and begins to drop packets. This analysis suggests that, if we want to achieve any kind of reasonable performance, we need to limit any segment that we're asking to carry 512 Kbps using 256-byte packets to no more than five inserted users.

This is a significantly different conclusion than we got from our bandwidth analysis, which suggested that a 16-Mbps token ring would easily sustain 512-Kbps throughput for 10 users. The discrepancy occurs because the bandwidth-centric



This illustrates a 512-Kbps throughput demand that a composite set of nodes places on the network. The 256-byte packets are uniform but small, and the waiting time for a token builds to roughly 6 ms before going negative at approximately 20 inserted stations. At that point, the real-world network becomes unstable and can drop packets.

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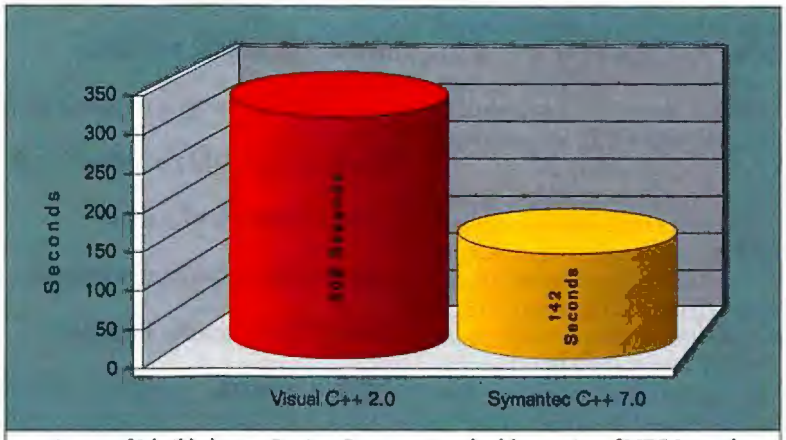
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analysis fails to consider the effects of competition. And as we can see, those effects can seriously reduce performance by having the workstations waste considerable time just waiting for access to the network.

Now, let's consider another case, where we have the same composite throughput demand as before, but we've increased the packet size to 2080 bytes. The results are shown in the figure "Large Packet, High Composite Rate" on the previous page. Notice the difference. Data-transfer efficiency has been greatly increased, since far fewer transmissions are required to move the same volume of data. The result is a stable network right up through 100 inserted stations. Even here, however, although the network is stable, once we get to 50 stations the wait time begins to exceed the transmission time, indicating unacceptable performance. Thus, if we wanted to segment this network conservatively, we'd keep each segment down to, say, 30 to 40 workstations.

One obvious point is that competition is greatly influenced by the number of transmissions per second, but hardly at all by the volume of data to be moved. Therefore, when considering competition, it's important to think of throughput in terms of packets per second, not bandwidth utilization and certainly not bytes per second.

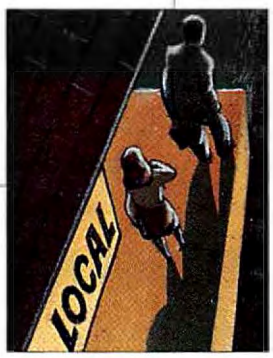
Drawing Conclusions

The analysis technique that we've just described should be used primarily as a qualitative aid in understanding just how sensitive network performance is to segment competition. Like all models, this one is based on certain assumptions, but there appears to be a high degree of correlation with observations of real-world networks.

We can draw several conclusions from studying this model. First, increasing competition on a network segment increases each user's average waiting time. Since more time is spent in simply waiting for the token, less time is spent in transmitting. Competition has the effect of limiting the amount of available bandwidth that can actually be used.

Second, simply upgrading older workstations with newer technology can create a competition problem where none previously existed. The newer technology is faster and can send out packets at a higher rate. This will create more competition on that particular segment and can result in slower network performance. When upgrading workstations on a large scale, therefore, don't forget to budget for additional network segmentation and the connecting hardware needed to link the new segments.

We might almost consider competition to be a parasite that feeds on available bandwidth. It robs a network of usable bandwidth by causing nodes to waste considerable time just sitting around, waiting for the token to arrive.



Software makes a difference, too. Rolling out a new application can also create a competition problem. It all depends on how the application uses the available packet payload and on how much data it needs to move. For example, some database applications move data based on the record size of the tables being accessed. For small data records, this can result in very inefficient data transfer and create a significant competition problem.

Software packages that use a windowing technology, such as packet burst, on a LAN or any other shared media can create a serious competition problem. Windowing technology allows a series of packets to be sent in rapid succession, with only a single required response from the destination (typically a server). This can quickly boost competition. For other types of applications, the normal, internal node-processing delays on the server and workstation actually help to limit competition.

One of the most subtly difficult things to understand about network segmentation stems from the seemingly intuitive observation that, since all traffic is generally directed to the same server, it eventually has to funnel down to the single segment that's occupied by that server. So why bother to segment the network? From a simple, bandwidth-analysis perspective, there's no clear advantage, and segmentation cannot be justified. The bandwidth argument suggests that even with multiple 16-Mbps segments, they eventually have to feed into a single 16-Mbps segment to reach the server. Thus the fastest that data can move is 16 Mbps, and any gains the network might have earned from parallelism will have been lost.

But we have already seen that such bandwidth-centered arguments fail to take competition into account; their simplicity is deceiving. We might almost consider competition to be a parasite that feeds on available bandwidth. It robs a network of usable bandwidth by causing nodes to waste considerable time just sitting around, waiting for the token to arrive. Segmentation, on the other hand, serves to limit competition and thus allows more efficient use of the available bandwidth.

A Continuing Concern

There's no simple, cookbook methodology for determining how to segment a network, and how big each segment should be, because there are so many factors at work. Our recommendation is to measure your current network traffic with a sniffer or other network monitoring device, then perform your own analysis similar to the one described above, using throughput and packet-size data that reflect your own network conditions. This will yield a rough measure of whether or not your network can benefit from segmentation and will indicate the maximum number of workstations you should place on any given segment.

Segmentation is also an important ongoing maintenance function that you constantly have to keep in mind when tuning your network. Any given network segment can become overloaded for a variety of reasons: adding new clients, upgrading older technology, rolling out a new application, or introducing windowing or other new technologies. And once a segment is overloaded, competition can drive its performance down dramatically.

So analyzing competition and segmenting your network isn't something you can do just once and then forget about. Periodically, you need to reexamine the way your network is segmented and make sure that individual workstations aren't spending too much of their time waiting in line. ■

Brett Husselbaugh is president of Tobek Computer Systems, a small LAN consulting firm in Dallas, Texas. He holds a master's degree in electrical engineering, with emphasis in telecommunications, and has analyzed many large LANs. You can reach him on the Internet at wbretth@aol.com or on BIX c/o "editors."

BYTE

Special Report

MOBILE COMPUTING

New and improved technologies are finally breaking down the barriers that impede the progress of mobile computing



Radio Days

The wireless infrastructure that will make mobile computers ubiquitous is incomplete, but it's slowly maturing.

PAGE 107



Color to Go

LCDs will likely remain dominant for the next few years, despite flirtations with new screen technologies.

PAGE 115



Brainy, Brawny Batteries

Smart batteries and new chemistries promise longer lives for tomorrow's mobile devices.

PAGE 131



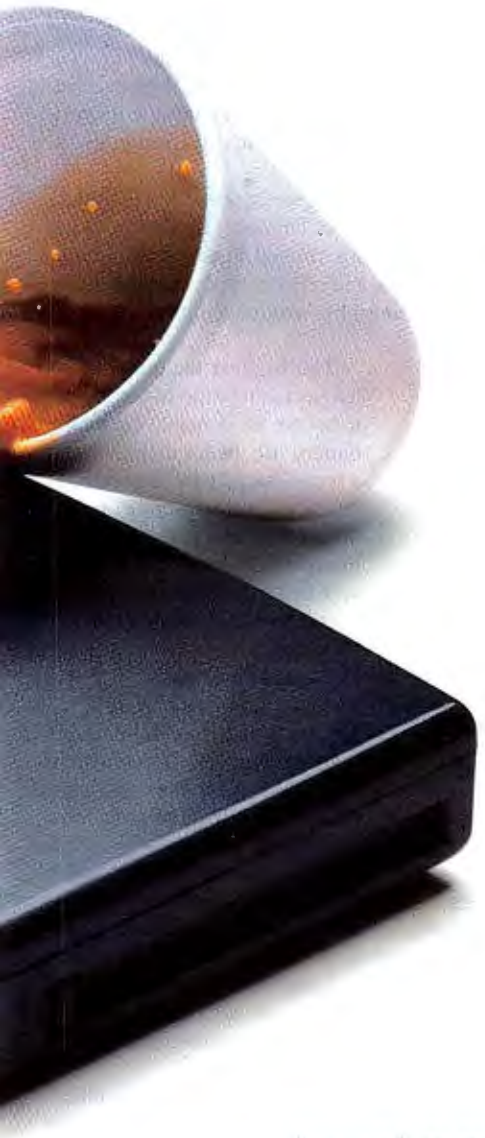
PDAs Bounce Back

Although significant obstacles remain, PDAs are gradually evolving into practical business tools.

PAGE 147


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Special Report

FROM HERE TO

ANDY REINHARDT

As long as there have been mobile computers, there have been compromises. It is simply not possible to provide all the capabilities of a full-powered desktop system in a package small and light enough to carry comfortably. The history of mobile system design has been about choosing which features and functions to sacrifice in favor of others.

However, those compromises are gradually disappearing. For example, surging yields and falling costs of active-matrix LCD screens have made high-quality color laptops almost commonplace. Indeed, thanks to greatly improved passive-matrix LCDs, color screens now constitute the baseline. IBM doesn't expect to produce *any* monochrome ThinkPads after 1995.

Power-conserving CPUs, augmented by sophisticated power management schemes, are driving top-of-the-line performance into notebook-sized packages. Hard drive and memory configurations are almost the same in desktops and portables. And nearly all mobile systems come with built-in pointing devices.

Even some seemingly insurmountable design hurdles are giving way to clever solutions. Consider the keyboard problem, for instance. Because human fingers aren't getting any smaller, how do you provide a full-size keyboard in a package the size of a subnotebook? IBM engineers came up with an ingenious answer in the ThinkPad 701C "Butterfly"—a keyboard that unfolds when you open the lid.

One indication of how small the gap between desktop and mobile systems has become is that Compaq engineers reportedly refer to notebooks as DFEs, or desktop functional equivalents. This nickname also reveals another truth, in the opinion of analyst Richard Shaffer: The only successful portable systems today are extensions to existing desktop architectures. Virtually all the radically different mobile devices introduced over the past three years—especially PDAs (personal digital assistants)—have failed to find their promised markets. Except for inexpensive organizers, such as the Sharp Wizard, no hand-held devices have established themselves in the marketplace.

The lukewarm reception for pen-based computers reinforces the belief that users won't accept too many compromises. Pen-based technology is still evolving, however, so dozens of companies both large and small continue to work on pocket-size devices that differ radically from conventional QWERTY-based laptops.

Today, the main difference between portable computers and deskbound systems is price. This isn't likely to change soon, because portables require rugged construction, miniaturized parts, LCD screens, and other components that make them cost more than their higher-volume commodity desktop cousins.

There's not much left that mobile computers don't do as well or better than desktop systems. And when the remaining challenges are solved, mobile technology will significantly change the face of computing.

The biggest technical challenges facing mobile computers today are the demands for longer battery life, better displays, and a broad-based wireless communications infrastructure. In addition, engineers are striving to improve user interfaces and provide better data sharing between portables and desktops.

The Grand Challenges

The holy grail of portability is a system that runs on batteries long enough for a round-trip flight from New York to Singapore. If today's notebook computers relied entirely on solid-state components and didn't have backlit screens, that goal wouldn't be out of the question; rechargeable batteries have improved significantly over the past few years. But the recent addition of large-capacity hard disks, LCD backlighting, color screens, megabytes of RAM, high-powered CPUs, and even such accessories as CD-ROM drives and stereo speakers are draining the batteries more quickly than ever.

Because battery technology is fairly mature and improving slowly, the most recent gains are coming from better power management. The latest portables know how to power down their hungriest components during idle periods and even scale back the CPU speed between keystrokes. One of the most interesting advances is the so-called "smart" battery that uses its own microprocessor to monitor and manage the

MOBILITY

rates of discharge and recharge. Smart batteries last longer and provide users with more accurate predictions about running and charging times.

Another, less obvious advantage is that smart batteries hide the complex charging characteristics of a battery from the host computer. This gives the engineers greater latitude when designing the power subsystem, and it provides a growth path toward emerging battery technologies.



One of the real surprises of the last few years has been the unexpectedly rapid arrival of lithium-ion and lithium-polymer batteries. Lithium ion had been used for years in tiny, nonrechargeable camera batteries, but techniques for safe recharging were developed only recently. Lithium-polymer, still a lab experiment five years ago, is on the verge of arriving in commercial products. Zinc-air cells, which are based on an older technology, are just beginning to achieve their potential, too. Author Gil Bassak in his piece, "Brainy, Brawny Batteries," describes these and other developments in mobile power systems.

Better than a CRT

Active-matrix LCD screens began showing up in portables about four years ago, but they were devilishly hard to manufacture and, hence, expensive. Now companies such as Sharp and Hitachi, and the Toshiba/IBM joint venture Display Technologies are cranking out millions of panels a year, and the difference in price between active- and passive-matrix screens has dropped to less than $1000.

It is now availability, not cost, that is holding back the universal adoption of active-matrix screens. To meet the growing demand for color portables, vendors are turning to improved passive-matrix panels. In "Color To Go," author Chris Chinnock explains how manufacturers are inventing new techniques for enhancing the quality of passive screens, such as the "active addressing" technology from Motif, a joint venture of Motorola and In Focus Systems.

For the foreseeable future, LCDs will continue to deliver the best combination of price and performance. But some alternatives are beginning to appear on the horizon. Among these are different types of silicon that could be used to fabricate higher-performance, higher-resolution displays. Other contenders include FEDs (Field Emission Displays), which are like flat CRTs, and AMEL (active-matrix electroluminescent) panels. None of these, however, is expected to show up in mass-market portables for several years.

Keeping in Touch

The dream of mobile computing will be only partly realized if "anytime, anywhere" data communications isn't made more practical. This is especially true for hand-held devices. Some analysts are convinced that the limited acceptance of PDAs has a lot to do with their limited capabilities for

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wireless communications. They think PDAs should be designed as wireless communications devices that can also compute instead of as pocket-sized computers that have some ability to communicate.

Over the past three years, two trends have strengthened the support for communications in mobile systems. The first is that an increasing number of notebooks offer internal data/fax modems capable of speeds as fast as 14.4 Kbps, eliminating the need to carry an external modem. (Often, however, the internal modem is still an extra-cost option.) The second trend is the rising popularity of PCMCIA slots and user-installed modem cards. These two developments are making it easier to get on line while traveling on the road.

Adding a modem solves only half the problem, of course. The greater challenge is tapping into a communications infrastructure that is not very accommodating to mobile computers. The wired telephone system is admirably ubiquitous, but plugging wires into phone jacks is a hassle and chains you to a wall. Wireless connections appear more attractive, but the infrastructure is nowhere near as mature as the wired phone system.

The first and most obvious contender in wireless communications was analog cellular, because it is so widely available. But the early round of products was relatively expensive, slow, and unreliable. This provoked users and vendors to consider other approaches, such as private packet radio networks and the promising CDPD (cellular digital packet data) standard, which interleaves short data packets into the breaks between analog cellular calls. Companies such as Motorola laid out grand road maps for their PCMCIA wireless modems, and analysts made bold predictions of market growth.

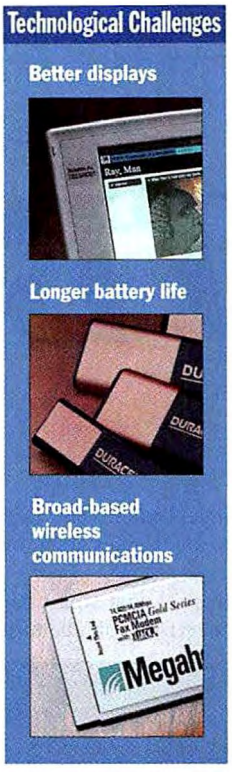
But instead there has been a resurgence of interest in analog cellular, fueled by the arrival of new technologies such as AT&T's ETC (Enhanced Throughput Cellular) protocol. The undeniable advantage of analog cellular is that it's here now and is relatively familiar and easy to use. This is partly because it is circuit-switched and connection-oriented, like the wired phone system, so it works with your existing communications software and applications. Also, if you've already got a cellular account, you needn't subscribe to another service for data communications.

Meanwhile, the growth of other wireless options continues, but at slower rates than predicted. The Ardis and RAM Mobile Data packet radio networks have attracted enormous attention and serve many customers, especially in vertical markets. But because they're proprietary and not yet universally available, they haven't become broad-based, horizontal solutions. CDPD is finally emerging, but it's too early to assess its cost efficiency or acceptance. In "Radio Days," BYTE news editor Salvatore Salamone discusses these services and the efforts underway to bridge their differences.

Two additional technologies hold promise for the future. One is PCS (Personal Communications Services), the swaths of bandwidth recently opened up and auctioned off by the U.S. Federal Communications Commission. PCS devices and services will compete with cellular phones, and the competition could drive down prices for all forms of wireless communication. However, PCS won't be widely available for several years, and even when it is, service providers will probably focus their early attention on voice traffic rather than the more specialized market for data traffic.

The other essential communication technology of the future is software agents. (See "The Network with Smarts," October 1994 BYTE.) In IBM's proposed Intelligent Communications services, for example, agents that "live" in the network represent your preferences, so you can transparently connect to services using a variety of protocols and devices. Software agents hide specifics of the network from users, reducing the complexity of dealing with different services and providers. They can also route and filter messages, minimize traffic and connect time, convert data among different formats, and help users locate services on the network. Middleware tools such as Oracle in Motion will simplify the job of developing WAN-aware programs.

In the world of wireless communications, standards are growing up from hardware and down from applications. In the future, you'll be able to buy a single PCMCIA card that will support different modulation schemes and transparently connect itself to a variety of services. Applications will talk to the networks through common APIs and network agents will do the bulk of your work—allowing you to focus on your job, not on the business of connecting and transmitting data.



Hanging On to Pens

Pen computing was undoubtedly overhyped, especially considering the state of the technology a few years ago. But the idea remains compelling, because not even IBM's clever Butterfly solves the problem of squeezing a usable keyboard into a computer that's small enough to fit in your pocket. Despite the many false starts, pen computing has a future.

A few companies are still plugging away: Apple is establishing the Newton MessagePad as a vertical-market tool; Magic Cap–based PDAs, such as Sony's Magic Link and Motorola's Envoy, are slowly gaining a toehold; and Palm Computing's Graffiti recognition engine has been a surprise hit.

For some people, PDAs have a certain psychological appeal because they refashion the computer as a true consumer device, an able assistant and trusted electronic buddy. Although PDAs will gain from the same technological advances that benefit laptop computers, the problems they face are multiplied. Battery life, display quality, component costs, communication links—all are bigger challenges for hand-held devices.

In "PDAs Bounce Back," Michael Nadeau outlines the prospects for hand-held systems. The bottom line, however, is that PDAs aren't going to be ready for prime time for a few more years. Only then will the right combination of technologies exist to break through psychological and economic barriers and propel PDAs into the mass market.

The eventual success of PDAs will dramatically alter the mobile landscape. Laptop computers that run desktop-class OSes will still exist, of course, but they'll be more oriented toward intensive computing tasks, as PDAs take over some of their duties. Indeed, for many people, a PDA might be all the computer they'll ever need.

If you came late to the first personal computer revolution, stick around. The flourishing power of mobile technology offers innumerable opportunities for users and vendors to embrace new standards and create a truly new paradigm of personal computing. ■

Andy Reinhardt is BYTE's former West Coast bureau chief. You can reach him on the Internet or BIX at areinhardt@bix.com.

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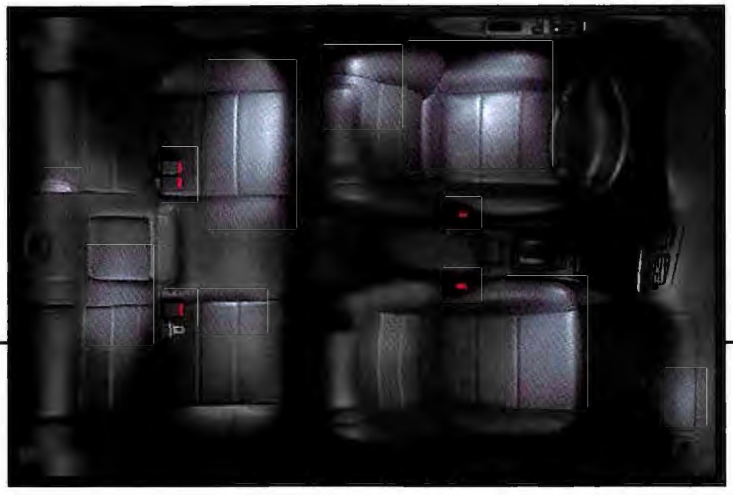
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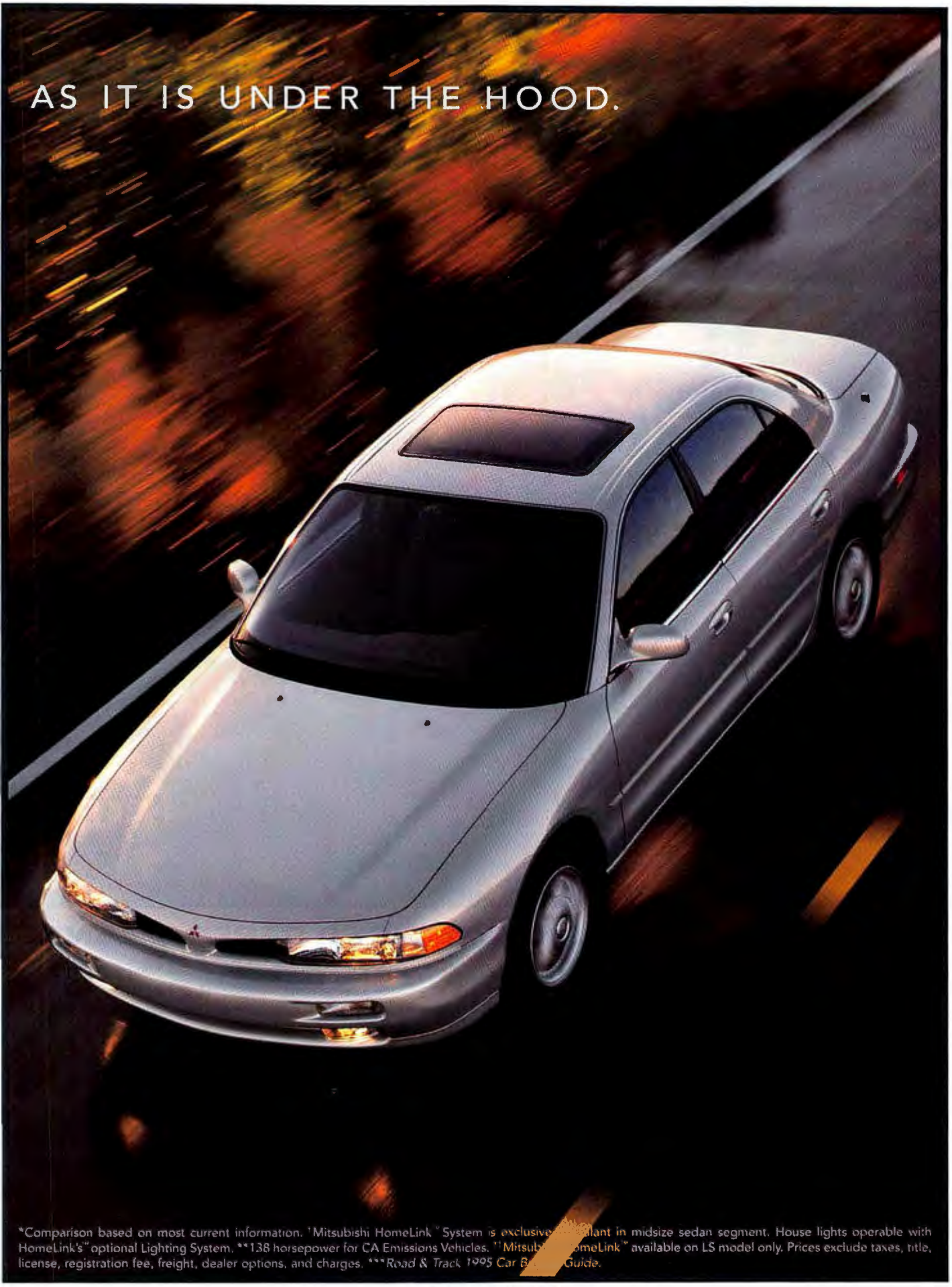
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Connecting to the office from remote locations is certainly easier than it used to be—many hotels catering to business travelers have added dataports to the phones in their guest rooms, and most airport terminals have public phones with modular jacks. But there are still numerous occasions when a wired modem connection is impractical or impossible: if you're visiting a client's office that has a digital PBX, for example, or if you spend much of your workday in a vehicle.

Mobile workers who have experienced the liberation of cellular phones are now demanding the same freedom for their digital communications. The most common need for a wireless link between a mobile worker and the office is to exchange E-mail. But many companies would also like to use wireless networks to connect outbound employees with corporate data and applications stored on the network servers, minicomputers, and mainframes in the home office.

The expansion of wireless communications from E-mail and fax to remote data access will take some time. One study estimates that by the year 2000 about 25 percent of cellular data users will still be using wireless connectivity only for personal communications (E-mail and faxing). The rest of the market for cellular data services will be split among several distinct types of users (see the figure "The Changing Mobile Market" on page 108).

For example, service technicians need access to technical documentation or warranty information at customer sites. Delivery and inventory workers need to transmit information gathered about packages or products. And then there are the professionals who require a full mobile office that provides access to remote applications, data, and personal communication services.

The companies that are trying to address this market face a number of obstacles (see the text box, "Wireless Applications Stumbling Blocks," on page 108). Perhaps the most serious problem is that low-bandwidth connections still plague wide-area wireless communications. In many areas, wireless networks are limited to data transfer rates of only 4.8 Kbps, which is much slower than the 14.4- or 28.8-Kbps connections now taken for granted with wired modems and analog phone lines. Wireless WANs look even worse when compared to wireless LANs, which typically deliver transfer rates of 1 to 2 Mbps.

Many obstacles still hinder wireless communications, but expanded service offerings and new development tools are helping

Even if you're willing to settle for low throughput rates, there are still vast areas of the country (albeit mostly rural) that aren't covered by wireless services at all.

Another problem is the lack of standards. Businesses are often dismayed to discover they must use different wireless modems and develop multiple versions of the same remote-access software just to access all the different wireless services.

To compound this difficulty, some enterprises must develop their wireless applications to run on a wide variety of mobile platforms—everything from PDAs (personal digital assistants) with limited memory and processing power to Pentium-based laptops that rival high-end desktop systems. And as mentioned before, those mobile devices are increasingly expected to handle a lot more than just E-mail.

All these issues have kept most organizations from deploying wireless applications in any broad manner. Two notable exceptions are United Parcel Service and Federal Express, which use special wireless software and thousands of mobile computers to track all their packages in transit.

Fortunately, some recent developments should make it easier to create and deploy wireless applications. Wireless network providers are boosting their maximum throughput rates, new standards are coming with digital cellular networks, and there is a growing number of middleware products that should ease the chore of developing wireless

applications or adapting existing applications to wireless use.

Improved Services

Wireless services are available in virtually every major city in the U.S.—about 90 percent of major metropolitan locations have coverage, according to industry sources. And some kind of wireless service is available in about 30 to 40 percent of the rest of the country. All together, about 80 percent of the U.S. population can get access to wireless networking.

Currently there are four major wireless choices:

- The existing cellular phone network is the most familiar method, because all you have to do is connect an analog modem to a cellular phone jack.
- CDPD (cellular digital packet data) is offered by the large telecommunications service providers, including AT&T, Bell Atlantic Mobile Systems, Nynex, GTE, Southwestern Bell, McCaw Cellular, and Sprint.
- RAM Mobile Data is a service of BellSouth Mobile Systems and RAM Broadcasting.
- Ardis is a joint venture of Motorola and IBM.

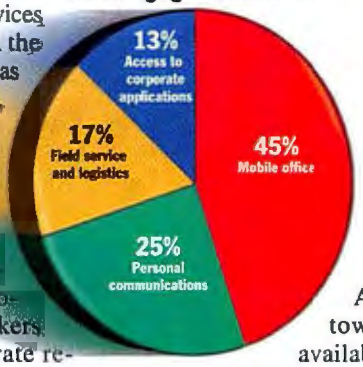
The two leading providers, Ardis and RAM Mobile Data, are constantly expanding their coverage into new sections of the country. That trend is likely to accelerate, thanks to increased competition from CDPD networks.

Less than a dozen cities had CDPD service by the end of 1994. But in January, the CDPD Forum announced that 20 additional cities—including New York, St. Louis, Dallas, and San Diego—would have commercial CDPD service by April. Carriers are expected to announce commercial CDPD services for the top 50 metropolitan areas during the first half of this year.

Despite this progress, CDPD still has quite a bit of catching up to do. Ardis—a two-way, store-and-forward, packet-based wireless network—is available in every state now and reaches more than 80 percent of the U.S. population.

However, don't get caught in a numbers game. Though the established service providers offer more extensive coverage, they may not cover the geographical regions in which your organization's mobile workers need to roam. Wireless data services are springing up from the cores of metropolitan areas and expanding outward, much in the way cellular phone networks began to spread. This is a logical way for services to grow, but it may not fit the needs of organizations that wish to provide their mobile workers with access to corporate resources from far-flung locations.

The Changing Mobile Market



By the year 2000, mobile workers will enjoy much more access to remote data and applications. That's in contrast to today's mobile market, in which wireless communications are primarily used for E-mail.

Source: McLaughlin & Associates (Chicago)

For instance, it's not hard to imagine a field service technician at a customer site in a rural area who needs access to technical documentation stored on the LAN back at the office. This is an excellent application for wireless communications, but before a company can rely on it, wireless data services must be deployed across broad regions of the country.

Breaking the Speed Barrier

Another challenge for the wireless data industry is to overcome the traditionally low bandwidths of wide-area communications. Early users had to accept 4.8-Kbps connections, which seemed frustratingly slow compared to wired modems. Ardis now offers speeds of 19.2 Kbps in most large cities, though smaller cities are still limited to 4.8 Kbps. CDPD services and RAM Mobile Data also operate at 19.2 Kbps.

Some service providers hope to carve out a niche market for higher-speed wireless services. For example, Metricom plans to introduce a 100-Kbps wireless service in five U.S. cities (Atlanta, Boston, Chicago, Seattle, and Washington, D.C.) by the end of this year. Metricom already offers a 77-Kbps service in parts of Silicon Valley.

Most users want the highest speed available when connecting from the field. When two wired modems or fax machines establish a link over an analog phone line, they automatically negotiate the fastest common speed they can support. After the link is negotiated, away you go. Ideally, wireless connections would work the same way. If Metricom's 77-Kbps service were available, your wireless device might choose that. If not, maybe it would route your connection through a CDPD link at 19.2 Kbps. And if you're in a small town and neither service is available, perhaps it would fall back on the 4.8-Kbps Ardis network.

Unless you've got a trunkload of wireless modems, however, your chances of accomplishing such a feat are small. Each type of wireless service requires a different type of modem. Even though all the major wireless networks—including Ardis, CDPD, and RAM Mobile Data—operate in adjacent parts of the 800-MHz to 900-MHz frequency bands, they each use different modulation and transmission methods. That means users must have a different proprietary modem to tap into each service.

And that was no joke about a trunkload of modems. Until recently, wireless modems were about the size of a brick. Carrying several of them wouldn't be practical for most people.

In March, the first PCMCIA wireless modems were introduced at the Mobile '95 show in San Jose, California. Both IBM and Motorola exhibited radio modems in the form of PCMCIA Type III cards. IBM also announced a modem that supports both CDPD and circuit-switched cellular service in a single device, providing mobile users with access to two wireless options. However, it's still a far cry from the level of standardization that lets you connect any wired modem to any modular phone jack and place a call over any local or long-distance telephone network.

There is, at least, some movement toward standardized command sets and common APIs for wireless modems. The PCCA (Portable Computer and Communications Association) has defined a set of extensions to the traditional TIA-602 AT (Hayes) modem commands. Any wireless modem, regardless of the service to which it's connected, can use these extensions.

In addition, the PCCA and the WINSock Forum are developing wireless extensions for the two most common network adapter drivers: NDIS (Network Driver Interface Specification) and ODI (Open Data-Link Interface). Their goal is to specify common APIs that will make it easier to run LAN-based applications over

Wireless Applications Stumbling Blocks

- Wireless networks must support increasingly complex applications
- Low throughput rates
- Support for a wide variety of mobile platforms
- Service not ubiquitous
- Lack of standardization

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wireless networks.

Wireless applications would be network-independent, so users could link their computers to any network. A single user could have access to several networks, or multiple users in different locations could have access to whatever services are available in their regions. In all cases, the same access methods would be used for any particular application.

Tightening Integration

Several vendors—including Motorola, CE Software, Oracle , Racotek, and Xcellnet—are concentrating on middleware that more tightly integrates existing applications with wireless networks. Their goal is to minimize the liability of restricted bandwidth.

For example, Oracle in Motion is a network-independent tool that lets a company develop Windows-based wireless applications. It uses agents to reduce the back-and-forth packet traffic that is common with LAN-based client/server software. In this case, Oracle in Motion uses an agent on the LAN to query a host.

Some of this middleware makes existing Windows applications compatible with wireless networks. For example, RadioMail Connection for Windows—developed by RadioMail and ConnectSoft—provides mobile messaging capabilities for Windows users. It's actually a wireless version of ConnectSoft's E-Mail Connection. With help from products like this, companies don't necessarily have to develop new wireless applications from scratch. Many existing applications can be used with little or no modification.

Thanks to new middleware, standardized command sets, common APIs, expanded geographical coverage, and improved transfer rates, the move to wireless WANs should be a much more manageable task. ■

Salvatore Salamone is a BYTE news editor based in Manhattan. You can reach him on the Internet or BIX at ssalamone@bix.com.

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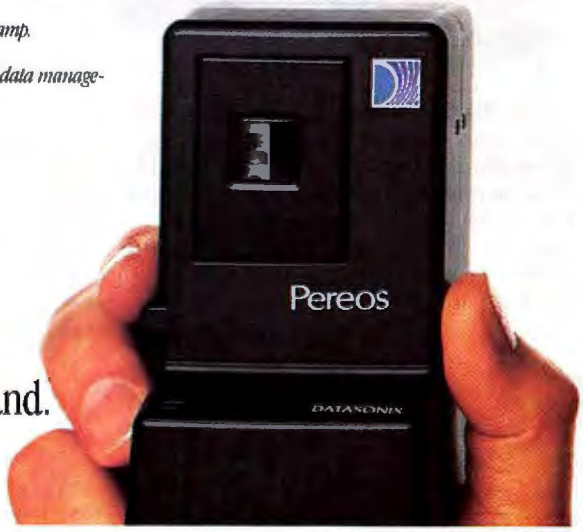
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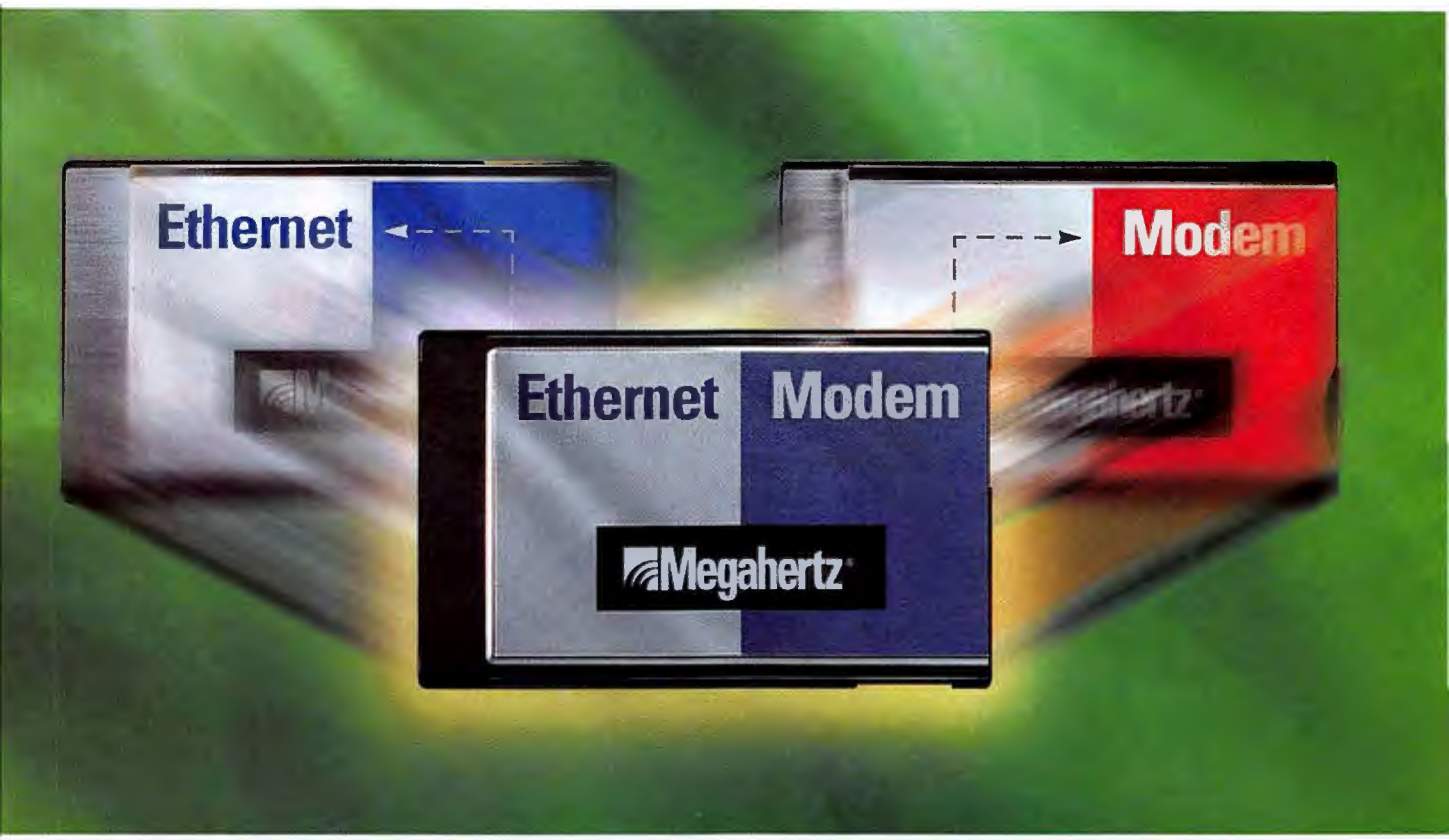
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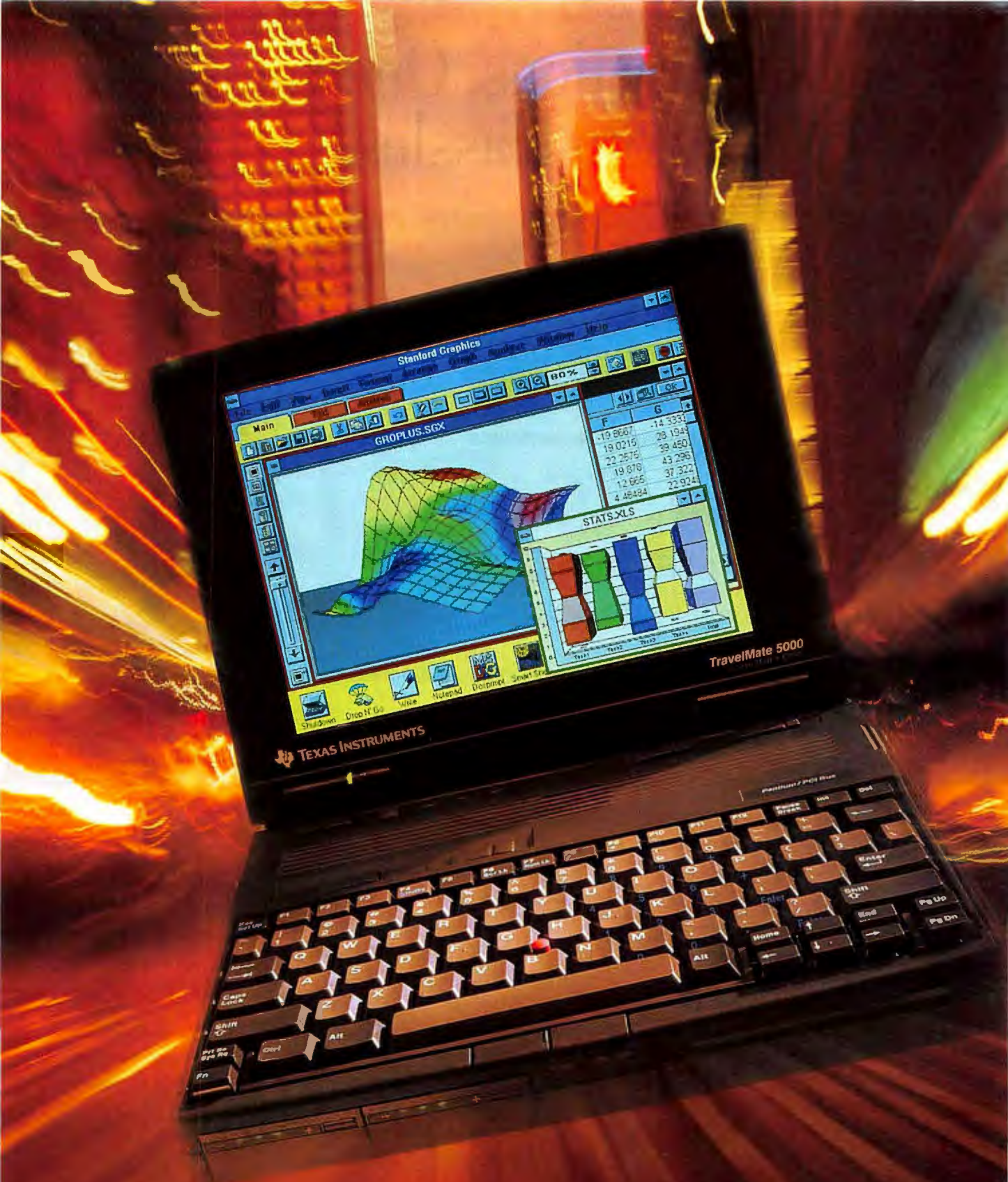
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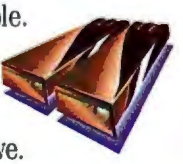
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Color to Go

CHRIS CHINNOCK



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Mobile-computer screens are roughly midway through a transition from monochrome to color. Five years ago, color screens on laptops were quite rare; five years from now, they will be not only commonplace, but taken for granted. Monochrome displays might still be offered on the lowest-end laptops in the future, and palmtop devices will cling to monochrome displays for a while longer. But for the most part, color screens will soon be the accepted standard, just as they are on desktop systems.

User demand for larger and brighter color displays seems relentless, and it poses great challenges for the designers who struggle to cram these screens into smaller and lighter mobile systems (which users also expect to run longer on a battery charge). Newer display technologies could prove to be their salvation, but LCDs still have plenty of room for improvement and will continue to dominate the market for the immediate future. As new display and materials technologies evolve, prices will drop, and innovative combinations could lead to new categories of mobile-computing products.

Although some new display technologies for mobile computers are on the horizon, LCDs are likely to dominate for years to come

LCD Is King

Today's LCDs are essentially valves that regulate the amount of light emitted from an internal backlight. This light passes through several layers of polarizers, liquid crystal materials, and color filters. A screen image is controlled by a grid of electrodes that determines how much light passes through each grid point, or pixel.

AMLCDs (active-matrix LCDs) have a transistor at each pixel site, while PMLCDs (passive-matrix LCDs) don't. These transistors provide better control over the light that passes through the grid, enabling more vivid colors and faster updates without ghosting. This is particularly important for multimedia applications that use motion video. (See the table "Comparing Today's LCD Technologies" on page 122.)

Notebook computers represent a significant portion of the mobile-computing market, and both types of LCDs are almost universal in these systems. Passive displays cost less, of course, so they're generally found in lower-end notebooks. Active displays are likely to cost about twice as much as their passive counterparts for several years to come (see the figure "LCD Price Trends" on page 118).

Up to now, the vast majority of AMLCDs have been manufactured in Japan. High-volume manufacturing capacity is rapidly expanding—not only in Japan, but also in Korea and Europe. (The U.S. has only a few low-volume factories.) This expansion in Asia and Europe is being encouraged by the maturity and stable demand of LCD technology. "Customers have finally realized that active-matrix displays can do the job," says Dave Kuty, display project manager at Apple. "They have moved past the 'needing improvement' phase to the 'acceptable' stage."

Steve Depp, manager of home electronics and the subsystem technical and applications lab at IBM Research, agrees. "The development of AMLCDs is beginning to look like silicon's. There's a technology road map showing what levers you pull at what time. That's a sign of a reasonably robust technology."

With so much money and brainpower being invested in AMLCDs, suppliers expect to make progress in all aspects of production: screen quality and size, power consumption, weight, and cost.

"The primary emphasis this year will be to shift the 10.4-inch VGA-resolution [640- by 480-pixel] screens to SVGA [800 by 600 pixels] and to add more bits of color," says Joel Pollack, senior product marketing manager at

FEDS: WAIT A FEW YEARS

FED (field emission display) technology is another emerging display technology that's challenging LCDs. However, FEDs must demonstrate clear advantages over LCDs if they hope to gain wide market acceptance. Some developers believe the low power, wide viewing angles, and good image quality of FEDs will make them an attractive alternative. But others think the relentless advancement of LCDs may be too much to overcome.

An FED is essentially a flat CRT. But instead of using a single electron gun to scan a phosphor-coated screen, an FED has a grid of individually addressable electron emitters on a flat substrate. A second transparent substrate contains colored phosphors. Each emitter pixel is addressed with electrical signals that trigger the emission of electrons, which react with the phosphor screen to generate colored light. The ultimate goal is to produce a CRT-quality image in a flat package that consumes little power.

Several varieties of FEDs are now under development by different companies (see the box below). The most popular approach is to fabricate thousands or millions of tiny cone-shaped structures that emit electrons when voltage is applied. Some FEDs add voltage grids that help focus the electrons and increase voltage levels. Developing the materials, architectures, and manufacturing expertise to fabricate these electron emitters is one of the major challenges facing FED developers.

The advantage of using higher voltages is that it will let FEDs work with existing CRT phosphors. Lower-voltage approaches rely on the development of new phosphors that can operate efficiently and with long lifetimes at reduced voltage levels. There have been several recent advances in this area.

The discovery a few years ago that certain types of diamond films are excellent electron emitters is also helping to fuel FED development. Researchers are looking for ways to improve the quality of these films and make them easier to manufacture.

Several companies are expected to demonstrate prototype FEDs this year, but that doesn't mean mass production is imminent. As IBM's Steve Depp points out, "From our experience in the AMLCD [active-matrix LCD] area, once good prototypes are demonstrated, it's about 2½ years before they show up as actual products in quantity. It takes time to build a factory and establish other aspects of the infrastructure. Consequently, I think we're talking about mid-1997 before we see FEDs in any reasonable volume."

FED Developers

Canon
Tokyo, Japan, and Lake Success, NY

Coloray
Fremont, CA

FED Corp.
Hopewell Junction, NY

Futaba
Chiba City, Japan, and Plymouth, MI

Micron Display Technologies
Boise, ID

Pixel International
Rousset, France

Raytheon
Quincy, MA

SI Diamond Technology
Houston, TX

Silicon Video
Cupertino, CA

Texas Instruments
Dallas, TX

Sharp Electronics. "We are also talking about offering an 11.3-inch-diagonal display toward the end of the year."

There are many technical challenges involved in improving AMLCDs. For example, to pack more pixels into the same area, manufacturers are reducing the size of the transistors and line widths and are moving toward self-aligning photolithographic techniques. They are also developing improved fabrication processes and better test and repair procedures.

Many manufacturers are now on their third generation of fabrication equipment. The latest equipment reduces the number of steps required in the manufacturing process, resulting in faster, cleaner, and more uniform processing. The latest equipment can also process larger glass substrates. This permits more (or larger) displays to be processed on a single substrate. All these factors help to improve yields and reduce costs.

At the same time, both weight and power consumption are decreasing. "Today's 10.4-inch AMLCD is 11.5 mm thick, weighs 500 grams, and consumes 2.9 watts of power," explains Pollack. "By next year, we intend to get that down to 8 mm thick, weighing about 400 grams, and consuming less than 2 watts of power."

Many technical improvements are driving this progress, including more efficient backlights, better optical light guides, and more transmissive color filters. But the best gains appear to come from shrinking the transistors. This allows more light to pass through the LCD, so the screens can be brighter and also use less power. "A few years ago, I would have thought we were getting to the point of diminishing returns for AMLCD, but I now see steady progress being made throughout this year into next [year]," says Pollack.

The Future of Passive-Matrix

As mentioned earlier, passive displays still cost less and consume less power than active displays, so they're expected to command a considerable market share at the lower end of the notebook market. They will also dominate the market for low-cost hand-held devices. But as AMLCDs advance rapidly along the price/performance curve, manufacturers of PMLCDs will have to match those gains to remain competitive. Although they can take advantage of many of the same advances in manufacturing and materials as AMLCDs, the manufacturing techniques for PMLCDs are quite different.

For example, PMLCD manufacturers must pay special attention to the thickness of the cell gap through which liquid crystal material flows, which is located between the two sheets of glass that form the display. Preparing the glass surfaces for this material is a particularly delicate process because any small variations are clearly visible on the screen.

It has taken some time for the Japanese manufacturers to solve these difficult problems. But as they gain better control of their processes, new options become available. For instance, a technique known as *electrically controlled birefringence*, or ECB, can produce a color PMLCD without filters. If the cell gap is precisely controlled, it's possible to obtain various colors by applying different voltages. This wasn't feasible before, due to variations in the thickness of the cell gap.

"Now Japanese manufacturers are routinely holding this thickness to 0.1 micron, which is actually flatter than the glass itself," says Apple's Kuty. "While ECB is still in the research phase, if we can get adequate speed and some color capability, this technology might make an excellent ultra-low-power reflective display in a few years."

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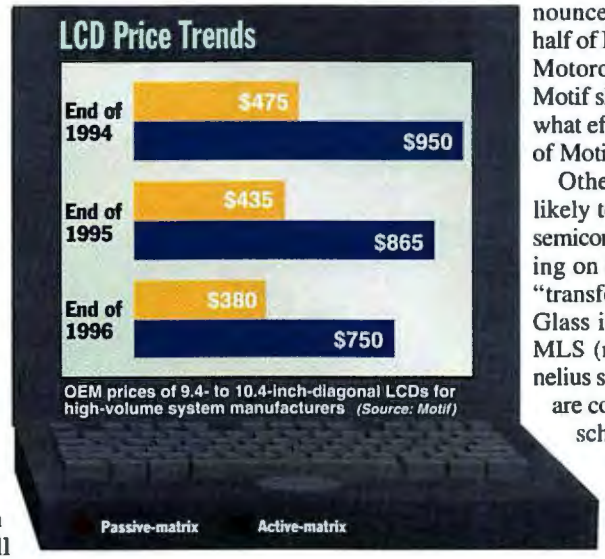
Circle 216 on Inquiry Card (RESELLERS: 217).

Another challenge faced by makers of passive displays is the limited number of addressable lines in the LCD grid. To overcome this, most manufacturers are adopting a dual-scan approach that adds a second set of drive electronics to the screen.

Low contrast is yet another problem. Some liquid crystal materials yield high contrast, but at the expense of slower response. For example, rapid mouse movements cause the cursor to "submarine" (i.e., temporarily disappear), and ghost images ruin the playback of motion video.

New addressing schemes may be able to solve these problems. For example, Motif, a joint venture of In Focus Systems and Motorola, will soon introduce passive displays that use a new technique called *active addressing*. This scheme updates the LCD rows semi-randomly under the control of a special ASIC.

"Our first generation of products will carry a 30 percent to 35 percent price premium over traditional passive-matrix displays, but this buys you display performance that is near active-matrix levels," says Motif vice president Kevin Cornelius.



Motif has lined up an impressive array of strategic partners, including Asahi Glass/Optrex, Kyocera, Standish Industries, and Tottori Sanyo. Together, they'll promote active addressing in the marketplace. Motif will supply ASICs to its partners and receive display panels in return. All the involved parties can then combine the ASICs and panels to assemble their final products. (In late March, In Focus announced that it would buy back almost half of Motorola's shares in Motif and that Motorola expected to sell its remaining Motif shares. At press time, it was unclear what effect this would have on the rollout of Motif's active-addressing technology.)

Other novel addressing schemes are likely to appear. Arithmos, a West Coast semiconductor start-up, is reportedly working on a passive-matrix technique called "transform addressing." In Japan, Asahi Glass is developing a method known as MLS (multiline selection). Motif's Cornelius says that MLS and active addressing are complementary technologies. "Both schemes increase response time and contrast, but MLS does not have a discrete gray-scale capability, which is necessary for displaying video images," he notes.

Another interesting addressing scheme, which is currently under development at Positive Technologies, has been dubbed *adaptive scanning* by company president Robert Hotto. "In standard passive-matrix addressing, each pixel is updated approximately 30 times per second, row by row," he explains. "But adaptive scanning modifies this update rate, customizing it for each row or group of rows. Higher-intensity pixels, or pixels that are changing

Active-Matrix EL Displays

Like FEDs (field emission displays), EL (electroluminescent) displays are emissive devices. Instead of modulating a backlight, as LCDs do, EL displays produce their own light by applying voltage to a phosphor. The advantages of EL displays include their rugged construction, ability to operate in an extended temperature range, and low power consumption. In addition, EL displays are the only ones that are completely solid-state.

Working with a team that includes Kopin and the David Sarnoff Research Center, Planar America is currently developing an AMEL (active-matrix electroluminescent) display. Each pixel site on this display has its own transistor, an approach that seeks to achieve the same advantages as Kopin's single-crystal LCD process (see the main text for details about this process). All the drive electronics and pixel transistors are fabricated in a modified silicon foundry. Phosphors are then deposited directly onto these electronics.

"AMEL fabrication requires only a single substrate," explains Ron Khormaei of Planar America. "This eliminates the assembly and alignment of two substrates, which is required for all other flat-panel technologies."

EL Display Advantages

- rugged construction
- ability to operate in an extended temperature range
- low power consumption
- only completely solid-state displays

AMELs may be well suited to HMDs (head-mounted displays) and portable-computing devices that require screens with low power consumption and extended operating-temperature ranges. That's why the military is interested in this technology. In fact, the U.S. Army is making preparations to flight-test an AMEL-based HMD next winter.

Development is still in its early stages, however, and moving from prototypes to volume manufacturing will take time and money. Planar recently received a $29 million contract to develop manufacturing processes that will allow pilot production of AMEL screens. The company hopes to begin sampling monochrome VGA displays and 640- by 512-pixel color displays by next summer.

Developing a bright and stable blue phosphor has long been an elusive goal for Planar. However, the company recently announced a breakthrough in this area. While the first samples are targeted primarily for high-performance military devices, Planar is also eyeing opportunities for HMDs and other applications.



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rapidly—due to fast motion, for example—are updated more frequently than slow-moving or static areas. This smart-addressing method essentially optimizes the pixel-update rate to conform to the type of imagery being displayed."

Adaptive scanning works for both passive- and active-matrix LCDs. Positive Technologies is working on ways to use the technique in automotive displays as well as in hand-held computing devices for package-delivery services.

Additional advancements may come from experiments with new kinds of materials, such as *guest-host* liquid crystals. With these, dye is added to the liquid crystal to increase contrast. Some of these displays dramatically boost the brightness of the screen without the use of polarizers. When used in a passive-reflective mode, they consume little power, sometimes in the range of 50 milliwatts. Guest-host liquid crystals work with both active- and passive-matrix displays.

Ferroelectric LCDs have been under development for a long time, especially at Canon. However, product introductions have been delayed for more than 10 years because of persistent problems with manufacturing and the mechanical instability of the liquid crystal material. Although prototypes are once again expected to appear this year, they face a skeptical audience.

"Ferroelectric LCDs require different driving electronics," says Apple's Kuty. "You just can't replace an active-matrix [display] with them. Unless they have some real advantage over active-matrix, people will be reluctant to invest the engineering time in them."

Emerging Markets

Today, the vast majority of mobile-computing devices are notebook computers, along with personal organizers and a few thousand PDAs (personal digital assistants). The market is likely to expand in coming years as new technologies enable the production of high-resolution displays that measure 3 inches (diagonal) or less. These displays will be the visual interfaces for communications devices designed to be carried around or even worn on the body. This market is just now emerging and could become quite significant in five years.



Small, high-resolution LCDs will enable a new class of head-mounted displays that give hands-free access to volumes of technical data.

For example, HMDs (head-mounted displays) are being touted as a new kind of interface for some types of portable computers. These aren't the full-immersion goggles associated with virtual-reality systems, but rather a single eyepiece that obscures only part of the user's field of vision. While these systems can be used for traditional applications, such as spreadsheets and word processors, new uses include the display of such things as technical manuals, blueprints, exploded diagrams, and even video clips that show how to, say, repair complex machinery (see the photo).

When HMDs are linked to voice-activated computers worn on the body, the result is a system that gives workers hands-free access to volumes of information from almost anywhere. For instance, a helicopter-repair technician equipped with an HMD wouldn't have to lug a heavy technical manual to the top of an aircraft to work on the rotor blade. Technicians working in cramped quarters could view schematics right on the repair scene, possibly even getting advice from a supervisor monitoring the situation through a small video camera and a wireless communications link. Factory workers could view a virtual template that helps them assemble complex components. CPSI and InterVision are among the companies developing systems for these types of applications.

New kinds of projection devices are coming, too. There's already a clear shift under way from CRTs to LCDs for projection panels. Most of today's projection devices are merely peripherals for laptop or desktop computers, but a few are starting to acquire some computing capabilities of their own. For example, In Focus Systems already offers a projector with a built-in floppy drive that doesn't have to be tethered to a computer to show a presentation.

Communications devices will benefit from improved display technologies as well. Portable phones will probably integrate small displays and enough computing power to enable the user to view E-mail messages, news bulletins, and other information.

The first device to explore this territory is the Simon, which was introduced last year by BellSouth Cellular and designed by IBM. The Simon is a combination cellular phone/PDA that includes an x86-compatible CPU, a fax modem, a PCMCIA Type II PC Card slot, 11 built-in programs, and a 4½- by 1½-inch touch-sensitive LCD screen. Better displays will almost certainly lead to more hybrid devices like the Simon.

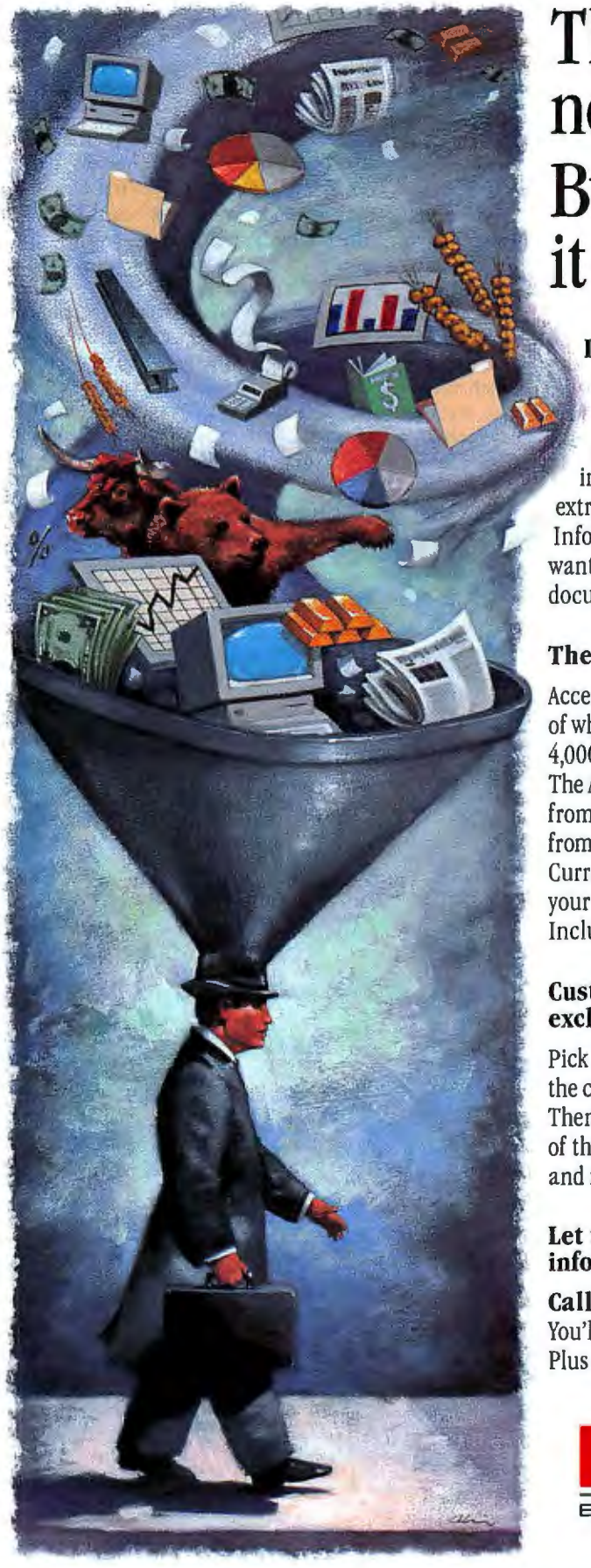
New Types of LCDs

By experimenting with different types of silicon, manufacturers are now producing new LCDs that have greater resolution than

COMPARING TODAY'S LCD TECHNOLOGIES

DISPLAY TYPE	COLOR QUALITY	VIDEO RESPONSE	CONTRAST	PRICE	POWER
Active-matrix	○○○○	○○○○	○○○○	High	○○/○○○○
Passive-matrix	○○	○	○○	Low	○○/○○○○
Active-addressing	○○○	○○○	○○○	Moderate	○○

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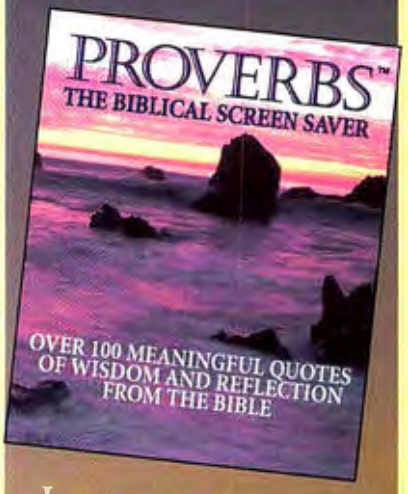
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Special Report Mobile Computing

before, as well as improved electrical characteristics. Some of these LCDs are better suited for the tiny displays in miniaturized devices, while others show promise for the full-size, direct-view screens on laptop systems.

The AMLCDs used in today's laptop computers are fabricated with *amorphous silicon*. This type of silicon requires discrete ICs for the off-screen electronics, which increases the display's weight, bulk, cost, and power consumption. These ICs are made in traditional silicon foundries from *single-crystal silicon*, which has excellent electrical characteristics. Another type of silicon is *poly-silicon*, which isn't as efficient as single-crystal silicon but is better than amorphous silicon.

All the on-screen transistors and off-screen electronics that are made for displays out of single-crystal silicon and poly-silicon can be fabricated simultaneously on a single substrate. This not only improves reliability and cuts costs but also offers some performance advantages. The result is a display with lots of pixels in a small area.

One company that's trying to commercialize single-crystal LCD technology is Kopin, which recently established a plant for mass production. "Right now we are shipping 1½-inch VGA monochrome display toolkits that allow systems designers to evaluate the displays, but 1280- by

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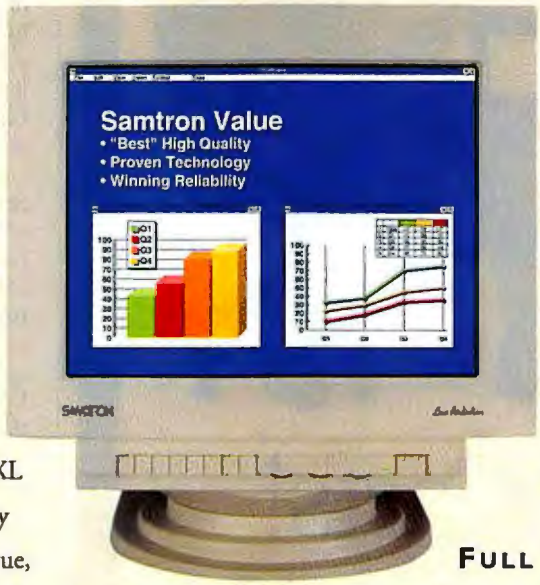
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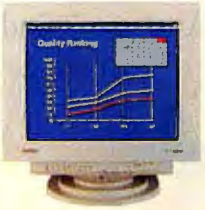
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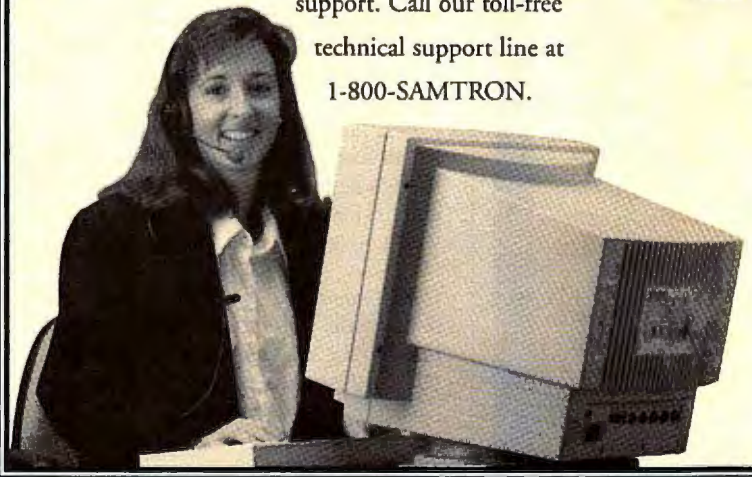
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1024-pixel displays will follow soon," says Jeff Jacobsen, Kopin's vice president for business development. "Last May, we received an ARPA contract to demonstrate an AMLCD with 2560 by 2048 resolution. No one has done anything like that before," he adds.

LCDs based on poly-silicon have many of the advantages of single-crystal-silicon LCDs, but their poorer electrical characteristics may prevent them from achieving the highest density displays. The viewfinders in camcorders often use this type of LCD.

Manufacturers such as Hitachi and Seiko-Epson are large-volume suppliers of poly-silicon LCDs, but that situation is changing. Camcorder manufacturers recently established their own poly-silicon lines, so outside suppliers are looking for new market opportunities, such as HMDs and projection devices. Hitachi and Seiko-Epson have increased the resolutions of their viewfinder displays and, along with Sony, are now sampling VGA-resolution products. A U.S.-based company named Sarif (a joint venture of In Focus and the David Sarnoff Research Center) was recently formed to commercialize poly-silicon displays.

Other companies are developing new technology for larger, direct-view displays based on poly-silicon. Current fabrication techniques use a high-temperature process that requires expensive quartz substrates, because the heat would warp a flat glass panel. Consequently, the goal is to find a low-temperature process. ARPA is currently funding this development in the U.S. "It will be two to three years before low-temperature processes are commercialized, but pilot line production might begin within 18 months," explains ARPA program manager Dave Slobodin.

Display technology is evolving rapidly on many fronts. And each advancement potentially enables the development of new kinds of mobile-computing devices. Although it's difficult to predict what these devices will look like, or even what they will do, today's mobile computers stand to benefit as well. As Sharp's Pollack puts it, "In five years, I think we'll be looking at a whole new paradigm in display technology. Displays may look the same, but it won't be today's technology." ■

Chris Chinnock is a technology writer based in Norwalk, Connecticut, who specializes in emerging and cutting-edge technologies. He can be contacted on the Internet at 76061.3671@compuserve.com or on CompuServe at 76061,3671.

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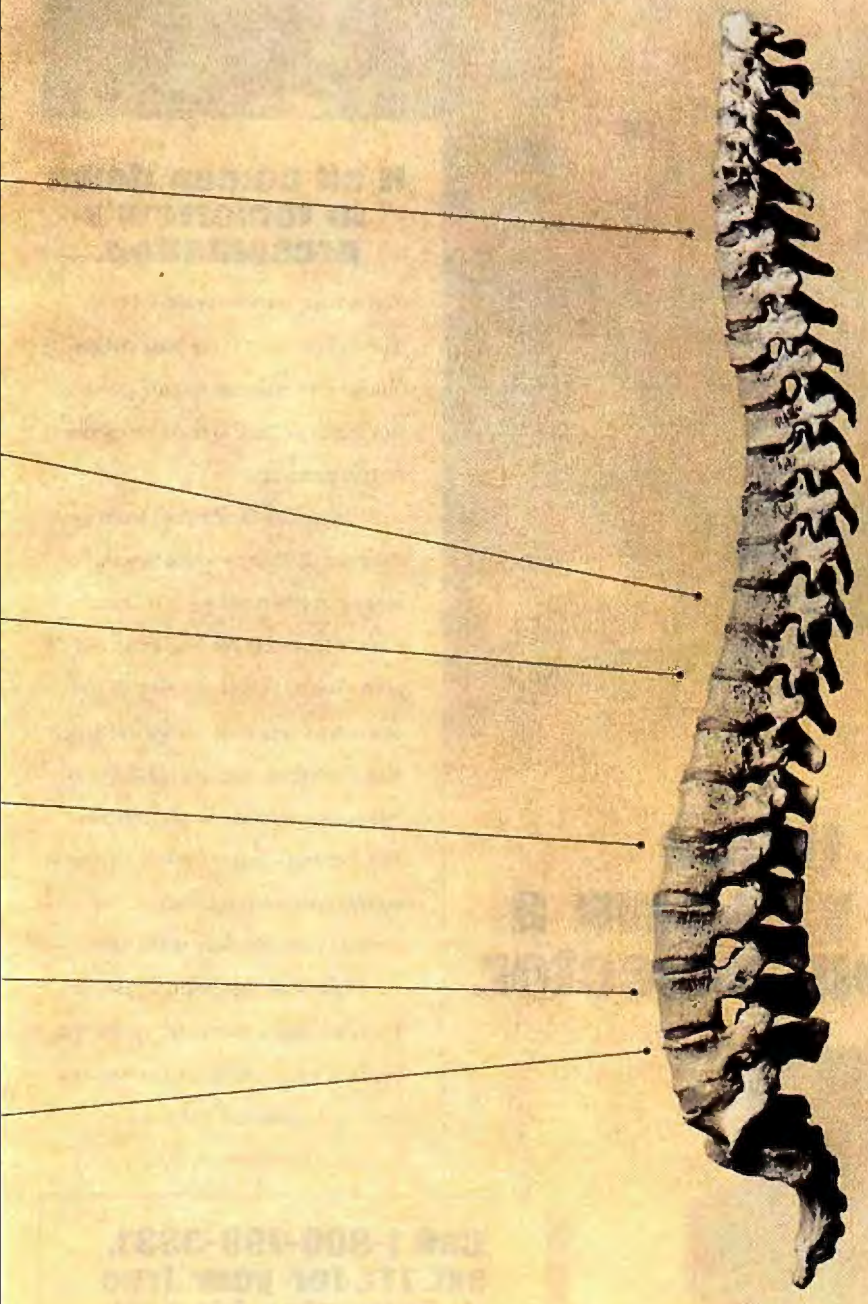


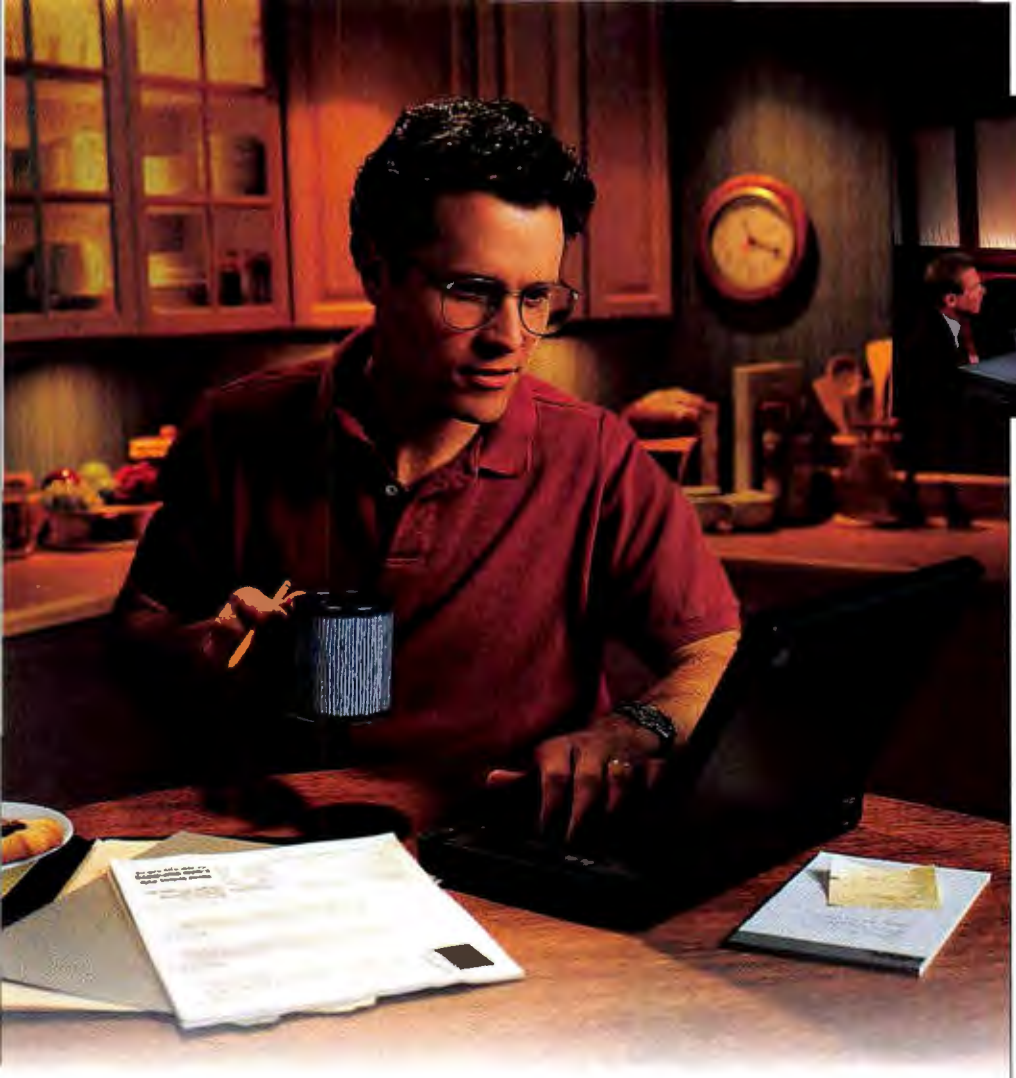
Fig. 1 Backbone

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Circle 241 on Inquiry Card (RESELLERS: 242).

Brainy, Brawny Batteries

GIL BASSAK



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In the continuing quest to extend the operating time of their mobile computers, manufacturers are finally getting smart—smart batteries, that is. And more powerful batteries, too.

Thanks to sophisticated electronics and power management subsystems, these new rechargeable batteries promise to live longer, better lives. Equally important, they can predict their own useful operating time with unsurpassed accuracy, ending the guesswork that has long plagued users. Smart batteries began appearing in notebooks from Compaq and IBM in 1993, and they're coming soon to many other systems.

In the past, you judged batteries by sheer electrical capacity alone. The stronger the battery, the longer it could run between charges. Obtaining a longer battery life boiled down to increasing the battery's size or reformulating its chemistry. To be sure, advances in chemistry continue to bear fruit. But the performance of existing battery technologies can be significantly improved by integrating smart electronics that report the battery's precise charging status, temperature, age, and chemistry.

Armed with this information, a mobile system can accurately predict how much longer the battery will last and adjust its power management tactics to squeeze more work out of the battery's remaining capacity. You see a "fuel gauge" that shows almost exactly how much battery time remains, and you have more options for extending that time.

When a smart battery finally runs out of juice, it also knows how much recharging it needs. This extends the overall life of the battery and keeps the mobile computer running at maximum operating capacity.

New chemistries linked to advanced power management systems are producing much more efficient batteries

Starting from Strength

Intelligence notwithstanding, a battery's fundamental strength starts with its chemistry. For that reason, battery makers are hard at work inventing and refining better rechargeable cells. And that work is paying off. Eclipsing the once-dominant nickel-cadmium batteries are NiMH (nickel-metal-hydride) and lithium-ion cells. Lead-acid, which is a popular chemistry for rechargeable batteries in other devices, has a doubtful future in mobile computing. Rechargeable alkaline batteries probably won't play a major role in laptop computers, but they could prove useful in smaller devices.

For years, nickel-cadmium has been synonymous with rechargeable batteries for portable tools and electronics. But because cadmium can be hazardous if the spent batteries are not disposed of properly, nickel-cadmium batteries have lost ground to cells built with the newer NiMH chemistry. NiMH batteries create fewer disposal problems and have at least 20 percent more *volumetric energy density* (i.e., energy for a given volume). NiMH batteries enjoy a service life that's about 40 percent longer than nickel-cadmium batteries.

What's more, nickel-cadmium is a mature technology, with faint prospects for further advancement. NiMH batteries, which were introduced six years ago, should continue to improve for years to come. For example, new sponge-metal NiMH cells from Panasonic are said to deliver up to 150 percent more power than comparable nickel-cadmium batteries.

These strengths have not been lost on systems designers, who are adopting NiMH cells as the battery of choice for today's mobile computers. For power tools and other consumer devices, nickel-cadmium batteries are still a mainstay. They are less prone than NiMH batteries to damage from high charge and discharge rates.

Lithium-ion batteries are gaining favor, too. They deliver about 50 percent more volumetric energy density than NiMH batteries and about 80 percent more *gravimetric*

energy density (i.e., energy per unit of weight). Also, lithium-ion cells have a low rate of self-discharge: 10 percent per month, compared to 25 percent or more per month for NiMH batteries. And lithium-ion cells do not suffer from the so-called memory effect that shortens the operational lives of nickel-cadmium and (to a lesser extent) NiMH batteries.

The memory effect occurs when a battery is repeatedly, but not fully, discharged. Over time, the battery begins to "remember" those partial cycles, causing the output voltage to drop well before the battery is fully drained. To prevent this from happening, most nickel-cadmium and NiMH batteries should be fully discharged before recharging.

Although lithium-ion batteries are the rising star in mobile computing, a potential problem is that lithium is highly reactive, posing safety concerns. Early versions were sometimes known to ignite or explode. In addition, some lithium-ion cells lose their capacity after repeated charge-and-discharge cycles. Still, lithium-ion's high energy density makes it an appealing mobile technology. These batteries are showing up in such notebooks as the Latitude XP from Dell, the HiNote from Digital Equipment, and the T3400CT Portege from Toshiba.

For smaller devices such as palmtops and PDAs (personal digital assistants), rechargeable alkaline batteries show some promise. They fall somewhere between NiMH and lithium-ion batteries in terms of volumetric and gravimetric energy densities. Available in AA and AAA sizes, they are well suited to the moderate power requirements of palmtops and PDAs. Rechargeable alkaline batteries can work alongside standard alkaline cells, have a five-year shelf life, and—like lithium-ion batteries—have no memory effect.

Looking ahead, two more battery chemistries are appearing on the horizon: lithium-polymer and zinc-air. Both have been under development for years and have commercial potential.

It is claimed that lithium-polymer cells offer twice the gravimetric energy density and 50 percent more volumetric energy density than lithium-ion batteries. Such high energy densities help offset lithium-polymer batteries' main drawback: a useful life of only 150 discharge cycles. In contrast, nickel-cadmium batteries can last up to 500 cycles; NiMH batteries, 300 to 500 cycles; and lithium-ion batteries, 500 to 800 cycles.



A typical fuel gauge for a laptop with smart batteries. When coupled to the computer's power management subsystem, smart batteries give accurate information about their remaining operating time. The computer can offer more options for balancing operating time and performance.

Zinc-air cells have two to three times as much gravimetric energy density as nickel-cadmium and NiMH chemistries, and about one-and-a-half times the gravimetric energy density of lithium-ion cells. In terms of volumetric energy density, however, they lag behind most other types of batteries. That's because a zinc-air cell requires more airflow, so it tends to be rather boxy and bulky. Engineers find it more difficult to fit zinc-air batteries into the tight quarters and sleek styling of today's laptops.

As with lithium-polymer batteries, zinc-air cells suffer from limited discharge cycles—if fully discharged, they'll endure from 25 to 50 cycles. And recharging can take as long as 10 hours. Still, zinc-air's high energy capacity yields longer run times between charges, so fewer cycles are needed over the battery's service life. In terms of total useful life, therefore, zinc-air is competitive with the other types of cells.

AER Energy Resources recently announced that it is developing a zinc-air battery for Hewlett-Packard's color OmniBook 600. AER says the battery will run from 10 to 15 hours per charge and withstand about 50 cycles if fully discharged. However, because most users will probably recharge the battery before it is fully discharged, they'll get as many as 200 cycles, according to AER. And there's no penalty for recharging a partially discharged battery, because zinc-air cells don't exhibit the memory effect.

Getting Smart

To make the most of a battery's inherent capacity, engineers are moving beyond chemistry to intelligent electronics. These smart batteries integrate microcontrollers that monitor and communicate information about the battery's past and present operating states. This information includes output voltage, temperature, and current drain (both instantaneous and average).

Having these details, a smart battery can accurately predict its operating life and recharging time under a given load. The computer's power management software can read this data to display a fuel

BATTERY TECHNOLOGIES FOR TODAY'S MOBILE COMPUTERS

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Nickel-cadmium	40 to 50	80 to 125	Delivers high current output; relatively tolerant of overcharging; withstands up to 500 charging cycles.	Mature technology with little room for improvement; cadmium is environmentally troublesome; noticeable memory effect.
NiMH	50 to 60	100 to 170	Environmentally safer than nickel-cadmium; somewhat less memory effect; 300 to 500 charging cycles.	More easily damaged by high charging currents or overcharging.
Lithium-ion	80 to 100	220 to 240	Higher energy than nickel-cadmium and NiMH; no memory effect; 500 to 800 charging cycles; low self-discharge rate.	Susceptible to damage from overcharge and overdischarge.

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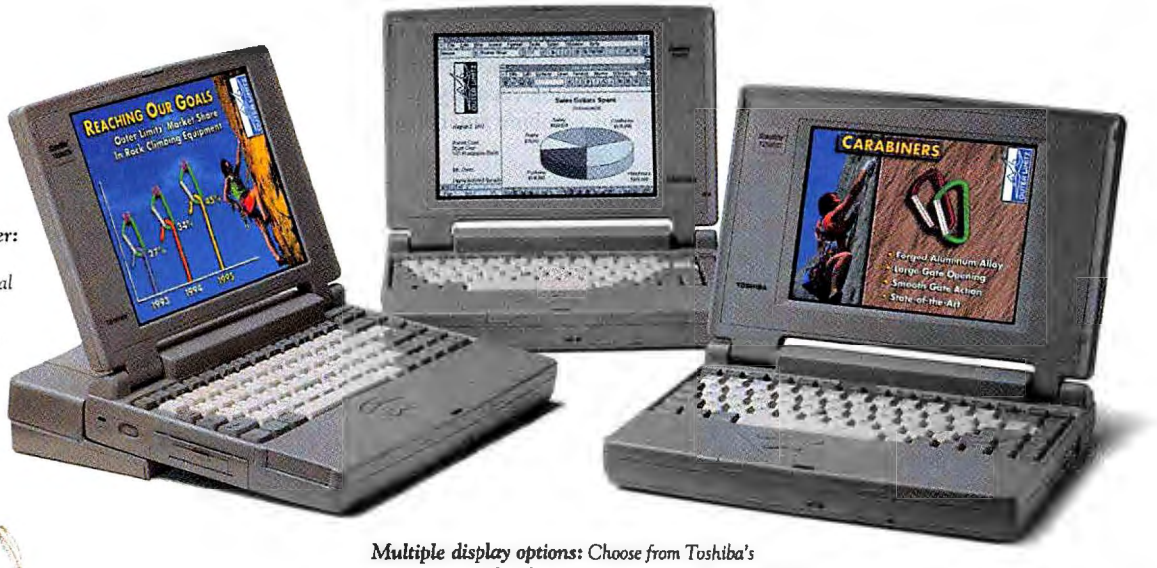


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gauge that's accurate to within 1 percent or 2 percent.

As a result, you get the most work out of your machine without getting caught with your voltage down and vital files unsaved. You can even set alarms that sound when the remaining operating time reaches, say, 5 minutes.

In contrast, the fuel gauges commonly displayed by today's mobile computers give only a rough indication of the remaining operating time. They draw their conclusions from output voltage alone, a measurement that is skewed by complex interactions among such variables as the battery temperature, electrical load, construction of the cells, type of chemistry, and usage history of the battery. As a result, today's systems warn you that power is low and force a shutdown before the battery is fully depleted. As much as 20 percent of the battery's capacity may still remain.

Smart batteries can also figure out how much time they need to reach a full charge and how much longer a recharge will take if you're using the computer at the same time. Some smart batteries communicate with a similarly smart charging system to tailor the voltage to the battery's requirements. The result: more efficient charging and longer service life.

Additional savings are possible with savvy power management subsystems. For example, if the computer detects a power surge—perhaps because a disk drive is spinning up to speed—a smart battery can alert the system to reduce power elsewhere, perhaps by dimming the screen momentarily or slowing the processor clock. You also get more working time because of the lowered discharge rate, and the reduction in the average current drain pushes the battery to operate at higher efficiency.

Wielding Power

Clever power management, with or without the benefit of smart batteries, is essential for extending battery life in portable computers. That's why power management functions are now integral to the CPUs, supporting chip sets, and BIOS firmware that are at the heart of the latest mobile computers. These subsystems monitor the computer's activity, throttle its system clock, and control power to the screen, disk drives, and other devices. Even on the desktop, the latest green PCs are adopting these techniques to meet the U.S. government's Energy Star guidelines.

In mobile computers, the power management subsystems take a more aggressive approach because they're balancing operating time against performance. The better ones let you set these priorities by adjusting sliders and other controls. You can select a power management strategy biased toward maximum operating time, peak performance, or anything in between. Smart-battery technology simply extends this flexible power management to the battery and its charging system.

Compaq introduced smart batteries in its LTE notebooks in 1993, and IBM began using them in its high-end ThinkPads at about the same time. Apple, which is another major laptop vendor, put smart batteries in its PowerBook 500 series last year. Canon recently announced that it would combine smart batteries with advanced power management in a pair of laptops scheduled for introduction this spring and summer. By the end of the year, at least a third of all new notebooks will include smart-battery technology, estimates David Heacock, marketing manager at Benchmarq Microelectronics, a company that makes chips for smart batteries.

High-end PowerBooks have two battery compartments; one of them accepts an optional PCMCIA-card cage. Each NiMH battery integrates a tiny processor card that communicates important variables to the power management subsystem, which is called EverWatch. Either the user or the subsystem can cut power consumption by spinning down the hard disk, dimming the screen, or slowing the clock speed of the computer's 68LC040 CPU. As these changes are made, the on-screen fuel gauge indicates the precise effect on battery operating time.

Another bonus you get with smart batteries is that the computer can adapt itself to more advanced battery chemistries in the future. As new batteries are developed, their integrated controller chips will supply different information to the computer's power management and battery-charging subsystems, thereby adjusting the operating-time calculations and charging characteristics.

Canon's new laptops will offer similar features, but with one exception: Their smart batteries could become as widely available as the AA penlight batteries that are used in your Walkman. The reason for this is a proposed standard that could eclipse the proprietary designs that are typical of most batteries for today's mobile computers.

Custom Designs

Mobile-computer vendors generally prefer to use custom-designed batteries because it allows them more freedom to match the batteries and the power management subsystem to the particular requirements of the mobile system. These proprietary designs can prove to be expensive and risky, however.

Every time the battery is modified, the changes affect all the phases of product development, including systems design, manufacturing, inventory, and distribution. An unforeseen problem, such as the shortage of a

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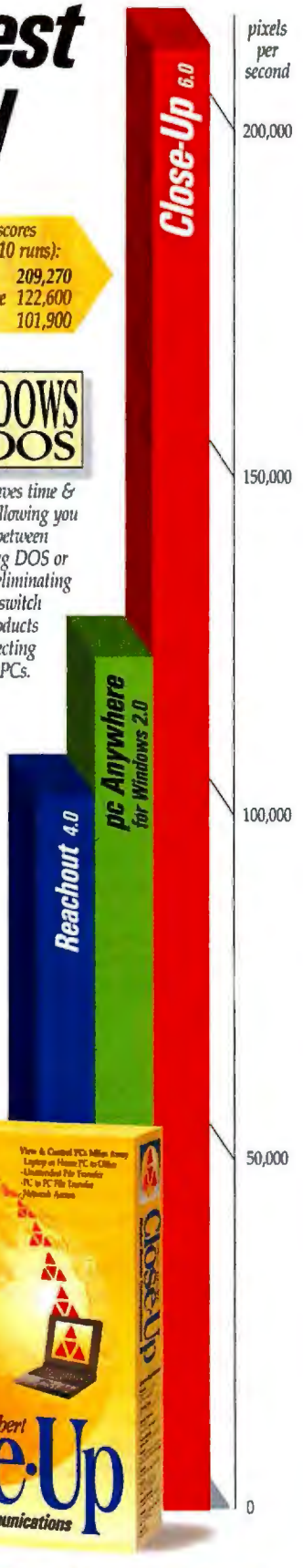
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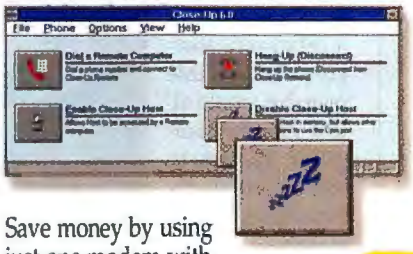
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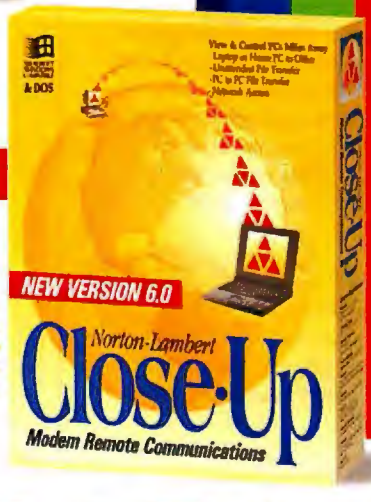
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key component, can bring manufacturing to a dead stop. And you may have a hard time finding the right battery to fit your computer, especially after the model is discontinued.

An industry standard for batteries could minimize these risks. Critical components would be readily available from suppliers who are eager to sell to a broad alliance of companies. You would have less trouble finding replacement batteries, and the additional competition should reduce prices.

However, some mobile-system vendors are reluctant to adopt an industrywide standard that neutralizes their competitive edge in battery technology. A standard that's too rigid might also restrict their flexibility to experiment with advanced designs. For these reasons, proposed battery standards are often viewed with caution—if not outright suspicion.

Nevertheless, Intel and Duracell have proposed a pair of complementary standards that are known as SMBus (System Management Bus) and SBD (Smart Battery Data). Together, these two proposals map out a relatively low-cost and reliable plan that would allow mobile-computer makers to add smart-battery technology to their systems.



Duracell is proposing five standard sizes for smart batteries. This would be more convenient for users, but some system vendors worry that it would restrict their design freedom.

In the approach from Intel-Duracell, the two-wire SMBus carries clock signals, data, and instructions to a smart battery, an SMBus host, a smart-battery charger, and other devices. The SMBus specification allows for any type of battery, regardless of its chemistry, voltage, capacity, or physical package. And it's designed to work equally well in single- or multiple-battery systems.

The SBD specification defines a wide variety of battery-related information that can be carried over the SMBus, including battery characteristics, manufacturer data, the current state of charge, low-power alarms, predicted and measured discharge rates, and control, status, and error messages. This information originates from logic and memory chips embedded within the battery.

The SMBus isn't meant just for smart batteries. Modeled after Philips Semiconductors' I²C communications bus, it's really a general-purpose communications channel that can share power management information with any number of devices. These devices can supply their model designations and part numbers, save their states immediately before a power-down event, indicate errors, accept control parameters, and answer requests about their status.

By carrying messages on a standard bus instead of on individual control lines, the SMBus can reduce the number of pin-outs on the battery and other power management components, reducing costs. It's also easier to add devices to the bus.

SBD feedback improves battery charging, too. When connected to AC power, the charger adjusts its output in response to periodic messages from the battery about its charging requirements. The battery can notify the charger if it detects a problem, such as overcharging, high voltage, or high temperature. In this way, the battery—regardless of its chemistry, construction, or condition—controls its charging cycle.

Gradually, the Intel-Duracell proposal is gaining supporters. Chip makers such as Benchmarq and Microchip Technology have announced that they will supply system components, as have BIOS makers Phoenix Technologies and SystemSoft. Canon is the first major system vendor to announce support for the standards.

However, most of the vendors are for the moment watching and waiting. Still other companies actively oppose the idea. One chip maker, Opti Computer, objects to paying royalties for using the SMBus. Apple says the SMBus would require a time-consuming and software-intensive redesign of its PowerBooks. The standards will probably appeal most to smaller vendors, who lack the resources to develop their own smart batteries and power management subsystems.

Duracell also wants the industry to adopt five standard sizes for smart batteries—similar in concept to the standard batteries (i.e., D, C, AA, AAA, and 9-V) that are used in other consumer devices. However,

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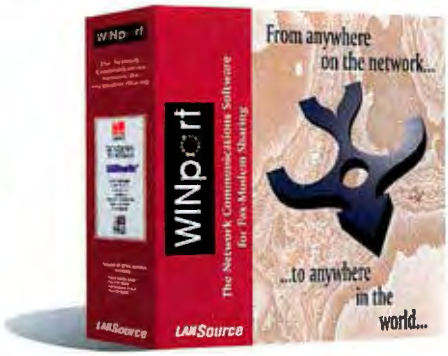
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vendors may be reluctant to accept this idea, too. Mobile-computer designers tend to leave the battery for last, assigning a higher priority to the overall shape and size of the computer, along with styling and ergonomic considerations. As a result, it's the space that remains after the other components are designed that defines the battery's exact shape.

As every laptop owner knows, today's batteries are anything but standard. Users will welcome Duracell's proposal if it doesn't impair performance. But battery design is an important decision that most system vendors would rather reserve for themselves.

At the Crossroads

To make it easier for system vendors to custom-design their own smart batteries, National Semiconductor and Energizer Power Systems, which is a division of Energizer Battery, have teamed up to offer an alternative. National Semiconductor supplies the electronics, and Energizer supplies the battery, which generally includes its own microcontroller. Thus, system vendors will save money because they don't have to start from scratch to make a custom design.

This partnership reflects a growing choice of discrete and chip-level circuits for power management and battery intelligence. For example, National Semiconductor also offers a smart-battery controller called the NeuFuz LMC6984. Using so-called neural-fuzzy logic, this controller is designed to optimally charge most types of rechargeable batteries without the need for more complex charger circuits.

It's becoming quite clear that battery technology for mobile computing is at a crossroads. If system vendors can be convinced that easy access to standard, low-cost batteries will help sell their laptops, they will be more amenable to the Intel-Duracell proposal. Otherwise, they will cling to the competitive advantages of proprietary batteries.

Dale Stolitzka, a senior applications manager at National Semiconductor, sees both camps thriving in the immediate future. "Companies that want a unique design will use custom batteries," he says. "Those driven by low cost and aiming for broadest market appeal will opt for standard sizes." ■

Gil Bassak is a freelance technical writer and journalist in Ossining, New York. You can reach him on America Online at GLBassak, on CompuServe at 72230,3526, or on the Internet or BIX at editors@bix.com.

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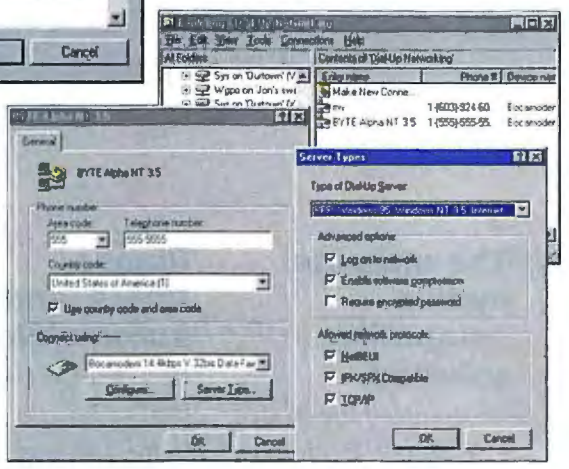
You Can Take It with You

Windows 95 keeps up with users on the go

JON UDELL

When Microsoft began designing Windows 95, the handwriting was already on the wall: Portable PCs would soon begin to displace desktop systems, acting as home computers and road machines. Windows 95's Plug and Play support—with dynamically loadable and unloadable VxDs (virtual device drivers)—anticipated the needs of the user who yanks a PC off the company network, pounds out a speech on an airplane, arrives at the conference hall just in time to print it, and jacks into the company network at the end of the day from the hotel.





The Briefcase (above) helps you manage files that sometimes live on a desktop or server machine and at other times travel with you on a portable PC.

Wizards (right) make it easier to navigate the forest of dialog boxes involved in the configuration of dial-up networking. Note that "Internet" is now a supported PPP server type, which means you can establish a dial-up connection to an IP service provider as well as to the office LAN.

The best way to reach this state of perpetual motion will be to use a dockable laptop. Punch the eject button, and you trigger a flurry of activity as Windows 95 negotiates with applications to release their hold on files and devices, and then unloads drivers. Dock the PC, and everything comes back. (Caveat: I've seen this done but haven't tried it myself.) Everyone will want to do this, but everyone doesn't have a docking station.

What does Windows 95 do for nondockable portables? On the hardware side, it handles the hot swapping of PCMCIA cards (as does OS/2 Warp), and it can monitor battery power and react to suspend/resume events. There's also a hardware profiles manager (again, à la OS/2 Warp) that can prompt you at boot-up time to choose between, say, an office configuration and a remote setup. Even with all this flexibility, though, you can still reboot more often than you like—as when you change your IP address. Windows 95 isn't as dynamic as NetWare.

Shiva helped Microsoft integrate PPP-based dial-up networking into Windows 95, and the results are impressive. From home, I can dial the office and run three protocols (IPX/SPX, NetBEUI, and TCP/IP) and two clients (Novell and Microsoft), navigating the full panoply of resources on our network. Negotiation of communications settings, a problem in earlier beta versions, was smoother in the current Beta 3. Resource browsing, however, remains maddeningly slow. Microsoft says its protocols are "slow-link aware," which helps make data transfer more robust. What would also help would be improved client-side caching, so that laboriously retrieved directory listings need not be refetched.

I had to dial in to a Windows NT machine because the Windows 95 remote-access server in the previous beta version had vanished in Beta 3. It will be available separately, and that's a relief to corporate IS managers. If they were suspicious of Windows 3.11's peer networking, they'll be terrified of deploying thousands of Windows 95 systems, each of which could be a security risk.

Windows 95's mail client, now called Microsoft Exchange, uses the LAN when you're in the office and dial-up networking when you're elsewhere. A nifty remote preview feature lets you scan message headers and specify which to retrieve. Users of nondockable portables will appreciate its ability to fetch messages nondestructively—that is, without altering the state of the post-office message store.

Why do that? If you operate separate home, office, and road PCs, you know that managing multiple local message stores leads to vexing synchronization problems. If you can't avoid these problems by consolidating everything into a multipurpose PC, it's handy to let multiple PCs share one post-office account without stepping on each other's toes. I used Exchange to remotely access both my Microsoft Mail and CompuServe accounts.

Mobile users will appreciate Windows 95's deferred-printing capability. You can print to a network printer when you're off-line. When you reconnect, Windows 95 finds the printer and prompts you to complete the job.

You can use the Windows 95 Briefcase to help synchronize files between your portable PC and a desktop or server system. You might, for example, keep a PIM (personal information manager) data file on a server to share it with others and include it in the nightly server backups. If you drag a copy of the file to your portable's Briefcase, it can move the file back and forth for you. When you're leaving the office, a Briefcase update copies from the server to your portable. When you return with new PIM data in the Briefcase, another update effects the reverse transfer. ■

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PDAs Bounce Back

MICHAEL NADEAU



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Call them what you like—PDAs (personal digital assistants), personal communicators, organizers, palmtops, or hand-held PCs—but sooner or later, you'll almost certainly be using a small computing device to communicate and manage information. Even today, in what might be considered the primeval era of PDAs, they help thousands of users keep track of schedules, maintain to-do lists, and serve as mobile nodes for exchanging data in remote locations. Mobile workers are using PDAs to gather sales statistics, retrieve information from on-line databases, and keep in touch with their home offices via paging services or even cellular phone networks.

So why, after years on the market, have PDAs failed to take the world by storm? Unfortunately, they are still products of an immature technology. While they can perform the above tasks and more, they're relatively inefficient, or prohibitively expensive, or both. Some companies that were planning to introduce PDAs have postponed their projects, and others (e.g., Eo) have vanished from the market.

But the good news is that PDAs are evolving rapidly. Prices for both systems and services are dropping. User interfaces and hardware designs are growing better suited for important tasks. Desktop connectivity—which was at first almost nonexistent—is widely available and much more sophisticated. Battery life is improving. More development tools are available and software is multiplying. Perhaps most significantly, wireless communications services are becoming more affordable and widespread.

Slowly but surely, PDAs are evolving into useful business tools. High prices and an inadequate wireless infrastructure remain obstacles.

Cost Controls

Today, price is still a major barrier to the proliferation of PDAs. A general-purpose PDA with integrated land-line and wireless modems will cost you $1000 to $1500. That's not cheap, but nearly two years ago such a device (the Eo Personal Communicator 440) cost nearly $3000.

Personal organizers have dropped in price as well. The street price of the Casio Z-7000, for example, has dipped from $700 to $400. The industry consensus is that sales will surge when prices hit between $600 and $700 for a device with two-way wireless communications and between $200 and $300 for a less communicative PDA.

A few key components are keeping PDA prices high. LCD screens are a relatively costly item—as much as $30 per unit. Because each PDA requires its own unique display, vendors can't take advantage of the economies of scale that notebook vendors enjoy. After the LCD, the most expensive component in a PDA is usually RAM. The less memory the PDA needs, the more control its designers have over system cost and size. For this reason, many PDA applications and some OSes are written in assembly language to conserve as much memory as possible.

The purchase price of a PDA often pales, however, when compared to the user's long-term cost of subscribing to a wireless communications service. RadioMail (San Mateo, CA), a provider of E-mail and other wireless services, charges $39 to $139 per month for access to the Ardis radio network. The lowest fee in that range allows you to send up to 100 messages of 240 characters each per month. Additional messages cost 21 to 36 cents each.

If you add paging services, connections to on-line services such as CompuServe, or access to information downloads such as stock quotes, your monthly bill escalates. On the bright side, many of these services were unavailable or more expensive when PDAs first appeared a few years ago.

Form Follows Function

PDAs are very diversified, and they'll probably become more so in the future, although this is a matter of debate.

continued

Some observers think each important function will spawn its own small, inexpensive, specialized device. Others believe that improved technology and economies of scale will eventually allow a few general-purpose PDAs to adequately and cost-effectively perform many different tasks.

"Each hardware manufacturer has different ideas about what they want to build," says Gordon Mayer, CEO of GeoWorks (Alameda, CA), which supplies GEOS to several PDA vendors. Those ideas seem to depend on the historical hardware and application focus of the company (see the table "The Wide Variety of PDAs").

For instance, Motorola (Schaumburg, IL) is a leading communications company, so it's no surprise that its Envoy and Marco systems emphasize E-mail and wireless connectivity. Cellular-phone vendor Nokia (Salo, Finland), which recently bought a stake in GeoWorks, is planning several cellular-based PDA-like products for the consumer and business markets.

Communications-based devices such as the Marco are expensive ($1000 or more) and are aimed at a relatively small group of business users. The personal organizer applications they include have a strong slant toward communications. For instance, the Magic Cap software from General Magic (Sunnyvale, CA) can automatically pull E-mail information from its address book when you send a wireless message.

Large Japanese consumer-electronics companies (e.g., Sharp and Casio) tend to sell devices that emphasize universal tasks, such as scheduling, note-taking, and to-do lists, instead of wireless communications. Their personal organizers offer nearly all the communications options of, say, Motorola's Envoy, but only as relatively expensive add-ons that seem more like an afterthought. For the most part, these organizers are not as versatile as the PDAs from Apple (Cupertino, CA), Sony, Motorola, and a few other vendors.

Traditional computer companies like Hewlett-Packard (Palo Alto, CA) tend to place a higher priority on making their hand-held devices compatible with desktop PCs. The HP 200LX has a QWERTY keyboard, uses MS-DOS, and comes with the LapLink file transfer utility from Traveling

The Wide Variety of PDAs



Apple Newton MessagePad 120



Casio Z-7000 Personal Digital Assistant



Fujitsu PoqetPad Plus



Hewlett-Packard HP 200LX

	Apple Newton MessagePad 120	Casio Z-7000 Personal Digital Assistant	Fujitsu PoqetPad Plus	Hewlett-Packard HP 200LX
OS	Newton Intelligence	GEOS	MS-DOS 5.0	MS-DOS 5.0
CPU	20-MHz ARM 610	NEC V20-based	16-MHz NEC V30	7.91-MHz 80C186
I/O ports	serial/LocalTalk, IR	serial, IR, headphone jack	serial (two), IR, keyboard	serial, IR
Standard RAM/ROM	1 MB/4 MB	1 MB/4 MB	2 MB/2 MB	1 MB/3 MB
Standard communications	none	none	none	none
Optional communications	modem, radio modem, pager	modem, cellular modem, pager	modem, radio modem	modem, radio modem, cellular modem
Expansion	one Type II PC Card	one Type II PC Card	one Type II and one Type III PC Card	one Type II PC Card
Input	stylus	stylus	stylus, optional keyboard	QWERTY keyboard
Desktop connectivity	optional	optional	optional	yes
Battery	alkaline AA or nickel-cadmium	alkaline AA	nickel-cadmium	alkaline AA
Weight	1 lb.	1 lb.	1.77 lbs.	11 oz.
Dimensions (inches)	8 by 4 by 1.2	6.8 by 4.2 by 1	10 by 4.6 by 1.5	6.3 by 3.4 by 1
Base price	$599	$499.95	$1275	$549

Note: Not every hand-held computing device is listed in this table, of course; however, it does represent the broad variety of devices. The proliferation of widely different hardware designs and OSes is reminiscent of the early days of desktop computers.

Software (Bothell, WA). A full range of communications options is also available.

Expect many more variations of these basic archetypes to appear in years to come. What you won't likely see are many PDAs larger than the currently available offerings. "People want products that look like a notebook [PC] or something you hold in your hand," says Ken Dulaney, an analyst with the Gartner Group (Santa Clara, CA).

Tweaking the User Interface

These varied approaches to hardware design and basic functions also dictate the limits of the user interface. Ideally, perhaps, users wouldn't have to confront more than one general type of interface on the different computers they use. But it is proving impractical to design a common user interface that's scalable from small pocket-size devices to larger hand-held units to full-size desktop systems. Some vendors, such as Apple, strongly believe it's preferable not to try—it's better to design a fresh interface that's optimized for PDAs rather than cling to desktop standards that are more appropriate to large screens.

Even among small mobile devices, however, there's enough variety to make user-interface design a challenge. An interface that works on a palm-size PDA might fail on a pocket-size pager.

Microsoft (Redmond, WA) has been struggling for years to make a version of Windows that fits on a PDA. That project, known as WinPad, is on a back burner. Attention has shifted to object-oriented OSes such as GeoWork's GEOS, Apple's Newton Intelligence, and General Magic's Magic Cap, which are inherently suited to small devices.

For one thing, these OSes are more modular, so the user interface can be modified for different classes of devices or vertical markets without rewriting other parts of the OS. Changing the interface of a conventional desktop OS requires either a major overhaul or the addition of a shell program—not a desirable alternative for PDAs, where memory is at a premium.

GEOS goes the farthest in decoupling the user interface from the underlying kernel. It supports a generic interface, which is common to all GEOS applications, and











Motorola Envoy Wireless Communicator	Motorola Marco Wireless Communicator	Psion Series 3a Palmtop	Sharp Zaurus ZR-5000	Sony Magic Link PIC-1000
Magic Cap	Newton Intelligence	Epoc (proprietary)	Synergy (proprietary)	Magic Cap
16-MHz Motorola I 68349	20-MHz ARM 610	8-MHz NEC V30H-based	9.216-MHz Sharp ESR-P16	16-MHz Motorola I 68349
Magicbus, IR, modem	serial/LocalTalk, IR	serial, parallel	serial, IR	serial, IR, phone headset
1 MB/4 MB	1 MB/5 MB	512 KB/1 MB	1 MB/4 MB	512 KB/4 MB
modem, radio modem	radio modem	none	none	modem
pager [1]	pager [1]	modem, radio modem	modem	pager
two Type II PC Card	one Type II PC Card	proprietary slots	one Type II PC Card	one Type II PC Card
stylus, optional keyboard	stylus	QWERTY keyboard	stylus, QWERTY keyboard	stylus, optional keyboard
yes	optional	optional	optional	optional
nickel-cadmium	nickel-cadmium	alkaline AA	alkaline AA	alkaline AAA or lithium-ion
1.7 lbs.	1.8 lbs.	9.7 oz.	13.6 oz.	1.2 lbs.
7.6 by 5.8 by 1.2	7.5 by 5.8 by 1.4	6.5 by 3.3 by .9	6.7 by 3.9 by 1	7.5 by 5.2 by 1
$1000 to $1500	$900 to $1400	$545	$749	$699.95

[1]Paging also supported via built-in radio modem.

Rewriting Handwriting Recognition

DAVID ESSEX

The Doonesbury strip. It haunts every conversation about handwriting recognition—and also serves as a milestone that marks where the technology has been and where it needs to go. When cartoonist Garry Trudeau ridiculed the Apple Newton's comical mangling of simple phrases, he gave voice to the public's unspoken verdict on the fledgling PDA market: Sorry, but your act isn't ready for prime time.

As a result of the Doonesbury debacle, the leading developers of handwriting-recognition software learned two lessons: do a better job of recognizing handwriting and do a better job of managing users' expectations. Developers say that users shouldn't expect a computer to recognize writing that even a person can barely recognize.

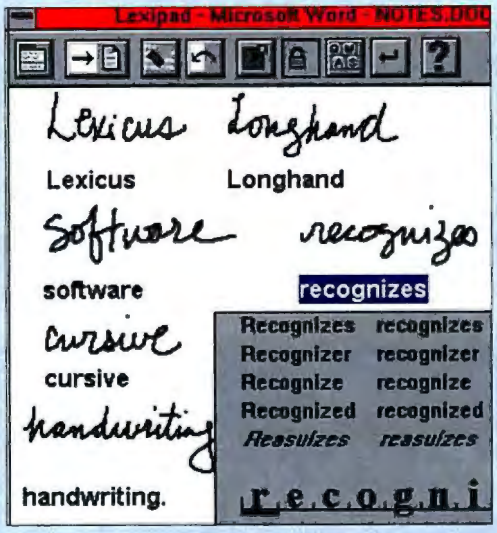
Selling into vertical markets helps, as Apple has learned by repositioning the Newton MessagePad. Pen-based computers deployed by a corporate MIS department are more likely to be accompanied by training, as well as the expectation that users must learn to work with the devices. Vertical-market applications are also more likely to involve the frequent use of forms, where constrained text entry greatly simplifies the difficult task of recognition.

PDA developers have also learned to downplay the emphasis on handwriting recognition as a key component of the user interface. The latest designs make use of point-and-tap selections and digital ink (unrecognized drawing and jotting stored as bit maps). But digital ink needs more memory and disk storage—which PDAs tend to have in short supply.

Perennial Challenges

Although the key issues are almost all software-related, some hardware challenges remain. The ice-like surfaces of LCD screens on early pen computers caused people to write less legibly than usual, and the weight and thickness of the stylus did not always mimic those of traditional pens. In response, we're starting to see writing surfaces with more friction from vendors such as CalComp, as well as redesigned styluses. Hardware vendors are also working to minimize parallax (i.e., how a user perceives the separation between the writing point and where the point appears on the digitizer).

Meanwhile, research aimed at improving recognition continues. There are two broad approaches: the method of throwing many specialized algorithms at basic pattern recognition (a trend also observed in AI programs, such as neural networks and expert systems); and application of contextual and grammatical post-processing, which is common in speech recognition.



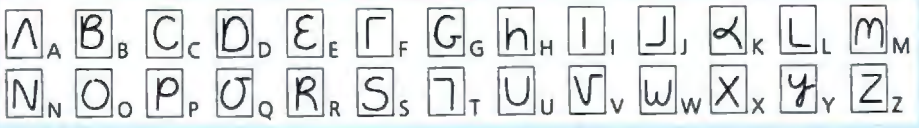
Lexicus Longhand uses neural networks to recognize raw images and patterns in cursive handwriting. It compares unrecognized words to a 25,000-word dictionary and uses statistical methods to generate a list of best guesses from which you pick the intended word. Lexicus says the process takes only 1 or 2 seconds and that overall recognition exceeds 90 percent.

Most first-generation recognizers compared each newly written character to a set of similar ones. Now, research is focused on using computational and statistical methods to spot deviations from the model characters. An example is the process of analyzing the different ways of writing an uppercase *A*, as explained by John S. Ostrem, vice president of R&D at Communication Intelligence (Redwood Shores, CA), the maker of PenDOS and Handwriter.

The right downstroke of the *A* might end at the bottom, or it might barely pass the crossbar. To account for such differences, recognizers use a technique called *elastic matching*. By measuring perhaps six or eight Fourier coefficients plotted between representative points on both the unknown and reference characters, an elastic matching algorithm calculates whether the coefficients fall within a permissible range. One study found the resulting error rate to be half that of linear (nonelastic) matching.

Grammatical and contextual analysis methods try to guess the likelihood of certain letters or words occurring near each other, based on language rules. If the pattern-recognition algorithms are uncertain about the identity of a *Q*, for example, a contextual analyzer might check the next character to see if it's a *U* and is at the beginning of a word. When the algorithm exceeds a particular confidence threshold, the recognizer interprets the character in question as a *Q*.

Lookup dictionaries have also become standard fare. They are frequently augmented by contextual algorithms or are narrowed to domains relevant to the user's special interests. A vendor, Lexicus (Palo Alto, CA), claims the dictio-



Palm Computing's Graffiti requires users to learn a modified version of the alphabet. When combined with Caps Lock and a separate numbers key, Graffiti purportedly achieves close to 100 percent accuracy.

nary in its Longhand cursive handwriting recognizer correctly guesses an unidentified word about 80 percent of the time (see the screen). Users choose their intended word from a list of candidates.

Using so many advanced techniques at once requires greater CPU power and memory capacity than is typical of today's hand-held devices. Accordingly, complicated neural-net approaches like those in Longhand work only on larger pen computers. Developers expect low-cost, high-speed RISC chips such as the StrongARM from Digital Equipment and Advanced RISC Machines to bring these advanced techniques to smaller devices.

Palm's Alternative

Another approach is Graffiti, a cross-platform recognition engine from Palm Computing (Los Altos, CA). Graffiti requires users to print with a simplified version of the English alphabet. All but six of the 26 letters are the same as their traditional uppercase and lowercase equivalents. The rest are generally based on parts of traditional characters (see the figure at bottom left).

The idea, says Palm Computing, is to make each character more distinguishable so that it won't be confused with others. (A special shift key lets you specify numerals.) Recognition is reportedly close to 100 percent, and Palm says that most people become competent with the new alphabet in about 20 minutes.

However, Palm's competitors—and many users—are skeptical about the idea of adopting a new alphabet. They believe that the computer should adapt to the user, not the other way around.

Most developers continue to concentrate on the challenge of recognizing existing writing styles. All they ask is to be judged by a fair benchmark. "If you write something and no one else can read it, don't expect a computer to," says Madeline Duva, Communication Intelligence's director of business development. "These things are not magicians."

David Essex is a BYTE technical editor for reviews. You can contact him on the Internet or BIX at dessex@bix.com.

a specific interface, which is left to the discretion of the developer. An abstraction layer separates and translates between these two interfaces. Mayer calls this "the most innovative piece of our technology."

Magic Cap's pictorial user interface will not scale down as easily to small pocket-size devices. The Newton's emphasis on handwriting recognition similarly limits its scalability (although the latest Newton applications rely less and less on freehand text entry). Both interfaces are more easily scaled upward; in fact, General Magic has announced plans for a Windows version of Magic Cap.

User interface design for PDAs is closely intertwined with the method of user input. Styluses are fairly standard, but for now, PDA vendors are avoiding handwriting recognition. Not only is it too unreliable, but the recognition engines also tend to hog processing power and memory. One promising alternative, however, is a recognition engine called Graffiti from Palm Computing (Los Altos, CA). Graffiti is available for Newton, Magic Cap, and GEOS systems (see the text box, "Rewriting Handwriting Recognition").

Connecting to the Desktop

Every PDA vendor is beefing up its desktop connectivity in response to user demand. "By far, the most important kind of communications is to talk to the desktop conveniently," says Randy Palmer, U.S. product manager for palmtops at HP.

Virtually all PDAs provide some means of exchanging files with PCs or Macs, but few provide this capability as a standard feature. That's not likely to change soon. Although many users want desktop connectivity, others avoid it and "dedicate a certain task to a certain device," says the Gartner Group's Dulaney. Adding file transfer features to PDAs to accommodate some users would increase prices and consume precious memory for all.

Even when the desktop connectivity gap is bridged, users face the problem of data synchronization. Most people want desktop connectivity as a means of simplifying data input; it's easier, for instance, to enter names and addresses into a card file with a desktop keyboard than with a stylus or a tiny PDA keyboard. But later, when you're on the road, you'll probably add some new records to the address book on the PDA. Now you've got two different versions of your address book—one on the PDA, and another back home on the desktop. Somehow you've got to synchronize the data.

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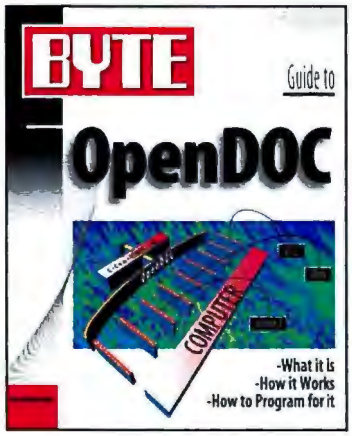
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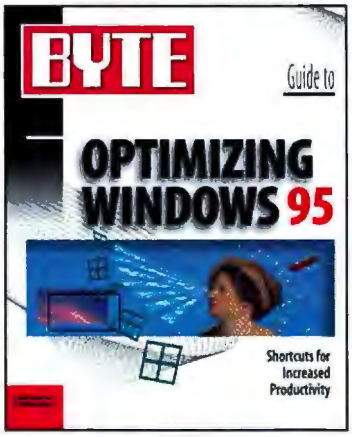




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such as scheduling and updating sales reports will become increasingly important. To avert chaos, everyone has to be working with the latest version of the schedule or the database. So PDA vendors and developers are working on better file transfer and data-synchronization tools.

For example, Psion (Concord, MA) is introducing PsiWin software for the Psion Series 3a Palmtop computer. The Palmtop files appear in their own volume on the Windows desktop, and you can transfer files by dragging and dropping.

Expected to ship in May, Psion's PsiWin will include many file translators for preserving attributes while transferring Psion files to many word processor, spreadsheet, database, or scheduling applications. PsiWin will also include a Windows PC version of the Series 3a's data application, which will let you create entries using the PC's full-size keyboard and transfer them into your Psion Palmtop. In a future release, Psion plans to add a Hot Thinking feature to automatically reconcile data within the files.

IntelliLink's (Nashua, NH) IntelliLink connectivity software has a similar feature that offers a graceful way to resolve duplicate agenda appointments: IntelliLink lets you send data between your desktop PC and PDA at the file level. IntelliLink supports several PDAs, including ones from Casio, HP, Psion, Tandy, and Sharp.

If your PDA and desktop machine have PCMCIA PC Card slots, you could solve this problem merely by swapping storage cards back and forth. Intelligent driver software could perform any necessary file conversions, and your PDA data would appear as just another hard drive on your desktop. Several vendors make PC Card cages that work with desktop PCs.

Extending Battery Life

Another challenge is building a PDA that can run for days or weeks on a fresh set of batteries. But measuring a PDA's battery life is tricky. People don't use PDAs like desktop computers; they tend to turn portable devices on and off more frequently, using them for brief periods of time. It makes little difference, therefore, whether a device gets 10, 50, or even 100 hours of continuous use. What does matter, says GeoWorks' Mayer, is that users get "unconscious" battery life. In other words, the PDA must run long enough so that users can recharge or replace the batteries at convenient, regular intervals.

Most PDAs sold today have backup batteries that preserve stored information even when the device is turned off. But adding components such as radio modems, cellular phones, or pagers can drain the main batteries much more quickly. Better power management is still a top design goal.

New battery technologies such as the optional lithium-ion cells in Sony's PIC-1000 are part of the answer, but what's more important is designing hardware that's less power hungry. "Power management is a distinctive art," says Mike Lundgren, U.S. market development manager at Apple's PIE (Personal Interactive Electronics) division. That art includes higher integration of system logic into ASICs, lower-power components, and better power management software (see "Brainy, Brawny Batteries" on page 131).

CPUs are doing their part, too. Motorola's Dragon I 68349 CPU draws only 300 milliwatts of power at 16 MHz; when idle, its power consumption drops to under 1 mW. Casio's Z-7000 uses an 8086-class processor and provides excellent battery life—although it has been widely criticized for its poor performance.

One remaining obstacle is that Type II PC Cards and controllers are 5-V components, but most PDAs use 3.3-V parts. A 3.3-V PCMCIA design is in the works, but PDAs that use them are at least a generation or two away.

Communications: The Driving Force

Most people agree that the key ingredient in moving PDAs into the corporate big leagues is two-way wireless communication. As mentioned before, the relatively high cost of wireless service is still an issue. However, the removal of other barriers could render this moot. Those barriers include a confusing lack of wireless standards, an incomplete wireless infrastructure, and no critical mass of wireless devices (see "Radio Days" on page 107).

Wireless data transmission methods range from analog and digital cellular to several flavors of packet radio, with satellite microwave on the horizon. No PDA vendor is betting the farm on any one of them. Motorola comes closest with its hefty investment in the Ardis packet radio

GEOS 3.0 INTEGRATES COMMUNICATIONS

GeoWorks's GEOS is one of the smallest general-purpose OSes available, needing only about 1.6 MB of ROM and 512 KB of RAM. It is optimized for low-cost, power-sipping, x86-compatible CPUs, and it provides developers with flexible options for designing user interfaces. Until now, however, GEOS's support for communications has lagged behind other PDA-oriented OSes (e.g., General Magic's Magic Cap and Apple's Newton Intelligence). GeoWorks aims to change that with GEOS 3.0.

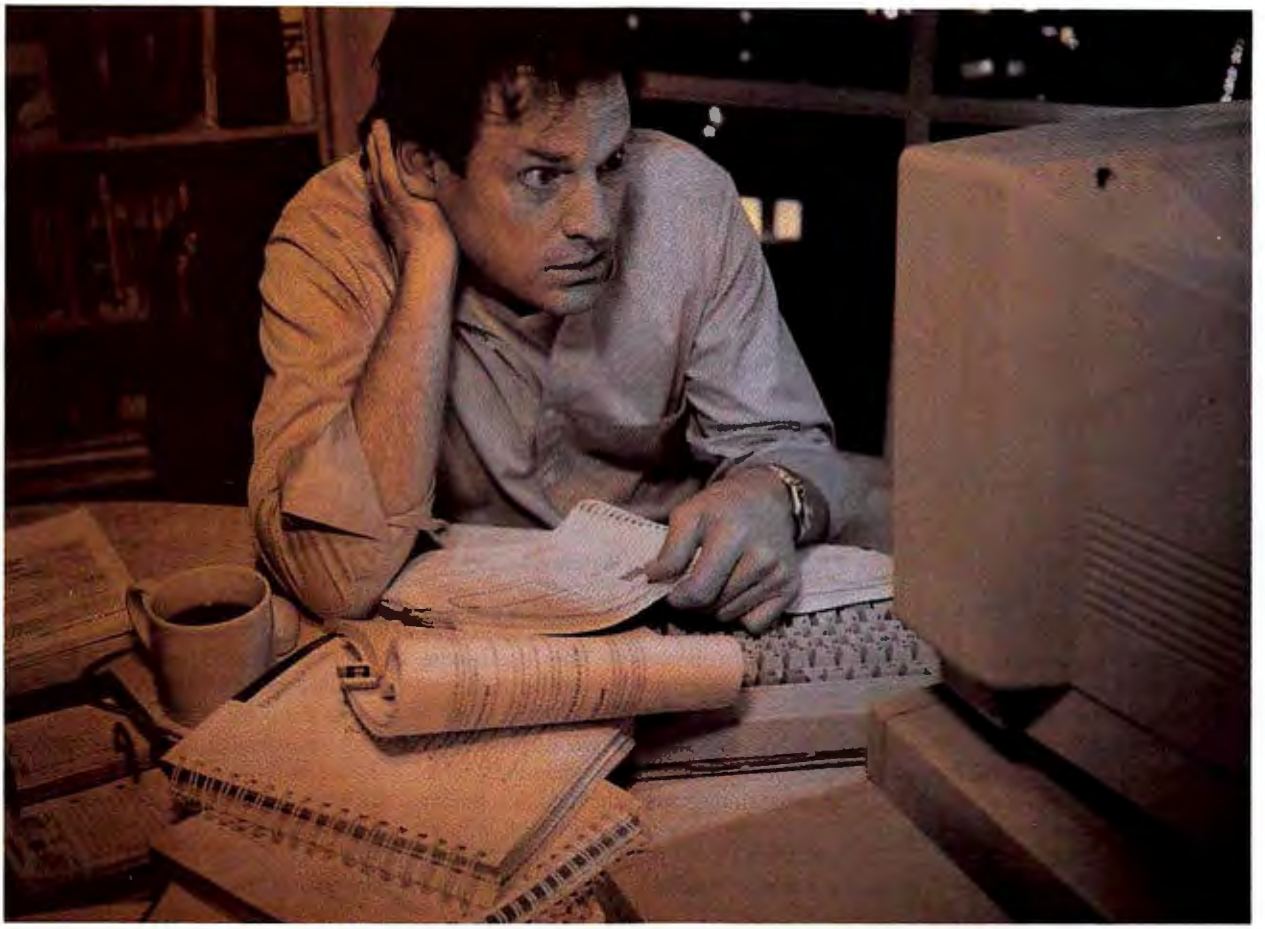
GEOS 3.0 adds a critical data communications layer atop the core OS. That layer includes a mailbox library, a socket library, transport drivers, and fax capability.

The mailbox library provides a systemwide inbox/outbox that streamlines the delivery of messages between applications or devices. Those messages can be E-mail letters, desktop file transfers, or faxes. The mailbox can hold messages and defer transmission until it recognizes that a transport driver has become available. For example, you could make a change to your calendar, store the change in the mailbox, and later use an infrared or wired link to record that change on a colleague's PDA or desktop computer.

Two-way communications channels are provided by the socket library. GeoWorks borrowed its socket API from BSD Unix; protocols include TCP/IP using SLIP and PPP and the IrLAP (Infrared Link Access Protocol) subset of the IrDA (Infrared Data Association, Walnut Creek, CA) standard. Geoworks says full IrDA support will be available later. This library allows a developer to build communications capability into an application without knowing how a given protocol works. The transport drivers handle the actual transmission and reception of messages, and they also provide a user interface for sending and formatting the messages.

GEOS 3.0 supports Class 1 and 2 fax using either 1-D or 2-D compression. The fax transport driver is integrated with the mailbox library, which means that GEOS 3.0 can defer fax transmissions and automatically receive incoming faxes.

Other improvements include simultaneous support for multiple languages and improved memory management.



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network, but the Marco and the Envoy can accommodate virtually any wireless transport. The universal strategy is to support every form of wireless (usually with third-party options) while keeping the hardware and system software flexible.

No wireless system as yet offers full coverage of the U.S., and the dream of a unified, global wireless infrastructure is years (perhaps decades) away. This forces some users to choose a wireless service based on availability rather than features or price.

PDAs that support two-way wireless communications will become more viable as more of them enter the field. It's similar to the burgeoning popularity of cellular phones; as more people use them and become more reachable away from their regular phones, there's more reason for other people to go cellular. The same thing will happen when more people become reachable via E-mail on their wireless PDAs.

The next communications feature likely to be built into PDAs, according to several sources, is two-way paging. Dulaney estimates the cost of goods to the manufacturer at about $25, which translates into an additional $75 in the retail price of a PDA. He believes that the added functionality would more than make up for the additional cost: "[Paging] is more valuable than [bundling Lotus] 1-2-3."

When will all these pieces come together so that PDAs can enter the business mainstream? Vendors are optimistically predicting this will happen in 1996 or 1997. But Dulaney expects them to flounder for at least the next three years. During that time, he expects OSes and hardware to mature to the point where PDAs can finally meet the expectations of most users. ■

Michael Nadeau is the author of the BYTE Guide to CD-ROM, Second Edition *(Osborne/McGraw-Hill, 1995). You can reach him on the Internet or BIX at miken@bix.com.*



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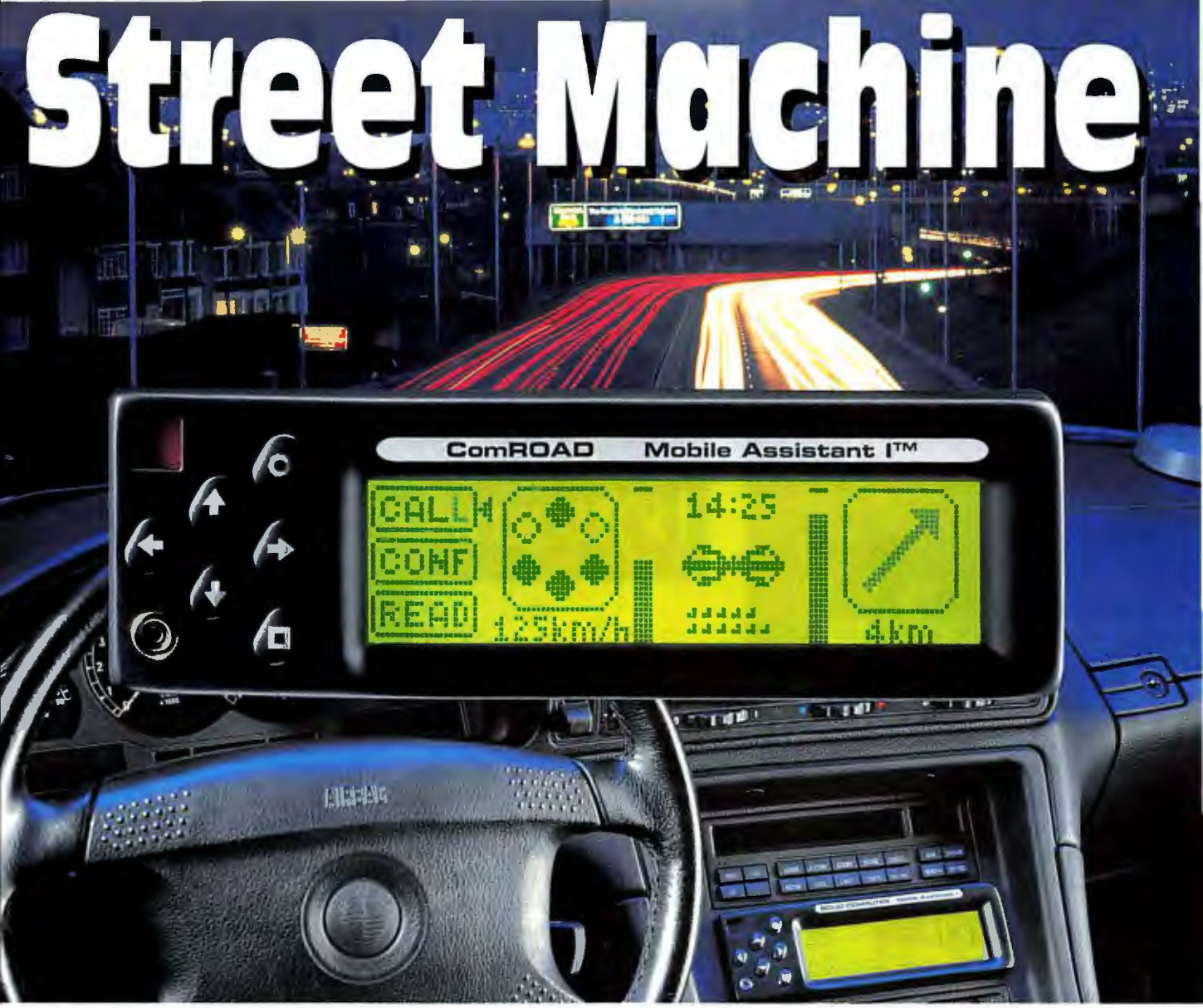
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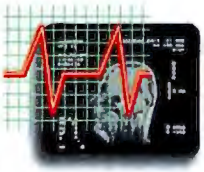
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Tales from the Trip

RAPHAEL NEEDLEMAN



It takes a bag of tricks to make a connection home from different parts of the world.

January 9 1995

Boston, Massachusetts. I'm setting up my new Boston apartment, and the Nynex guy who was here to install a second phone line has just left. I need to get my E-mail. So I run a phone cable from my modem to the wall outlet, add the right phone numbers to my communications program, click on the send/receive button, and walk away. Easy.

At BYTE's far-flung bureaus and at most hotels, it's the same story. Those little RJ-11 phone jacks are a conduit for my communications back to the BYTE home base in Peterborough, New Hampshire. Thanks to E-mail, my portable computer, and a PCMCIA modem, I'm never out of touch for very long. My traveling road kit consists of a Dell Latitude XP with a Megahertz X-Jack modem, a six-foot phone cable, a phone-line splitter, a small Swiss army knife, and a Mini Mag flashlight, all packed into a single briefcase. It's a little too heavy for my shoulder, but it contains everything I need to connect from almost anywhere—and I even have some room left in my case for papers and magazines.

However, I've had a few experiences when the basic road kit wasn't enough. So I've been gradually adding gizmos to the bag over time, as well as keeping a log of tips and tricks I've learned on my trip down the data highway.

January 16 1995

United Airlines flight 33, Boston to San Francisco. I notice that the seat-back phones have RJ-11 jacks. I plug in and try to connect. No joy. After a dozen different combinations of computer-dialed and manually dialed credit-card and access-code combinations, I call for help. I ask the AirPhone operator, "Do these phones work with modems?" The response: "They will very soon, sir." Unfortunately, not before I land.

Fortunately, the gentleman sitting next to me is in the printing business. We have a delightful discussion about the future of magazine publishing.

Lesson learned: The presence of an RJ-11 jack does not guarantee a usable phone line.

Later that day. Washington Square Inn, San Francisco. A typical hotel experience. The phone in the room doesn't have a modem port and the phone cable is stuck—the little tab on the modular plug has been snapped off. I have two options: Use the Swiss army knife to pry the cord out of the phone, or crawl under the bed and try to connect my computer to the phone jack on the wall. I opt for the latter. I plug the splitter into the wall, then plug both the phone and the modem into it. In ten minutes, I'm sending E-mail. No problem.

Lesson learned: Modern hotel design dictates that the phone jack shall be placed in the darkest, most inaccessible place in the room. Bring a small flashlight.

It's a poor worker who blames his tools. On the other hand....

January 18 1995

San Francisco International Airport, United Airlines Red Carpet Club. The yearly fees to this little oasis are worth it. The lounge has an entire wall with little cubicles, each equipped with its own phone, modem jack, and AC power outlet (hidden above the desk, under the fluorescent light). All I have to do is program my

PHOTOGRAPHS: LARRY DUNN © 1995

dialing string with my phone card number, and I'm in business.

Lesson learned: Airline clubs are worth the money because they have phones with data jacks. Sign up for one.

January 31 1995

IBM's conference center in Raleigh, North Carolina. During a break in a seminar on ATM, I go to the phone bank. There are several Rolm phones with standard RJ-11 cables plugged into the wall. I disconnect one and plug in my old but trusty Megahertz X-Jack modem. But when I try to dial, I get nothing, not even a dial tone. Hmm. Maybe it's a nonstandard phone line. No big deal, I can wait for my E-mail.

Later that night, at my hotel, I can't get on line. "No dial tone," says the modem. I try everything, but it's no use. My Megahertz has gone to the great bit-bucket in the sky. Apparently, plugging the analog modem into the digital Rolm system earlier that day was not a good idea—the higher voltage of the digital system blew out the Megahertz dialing relay.

Fortunately, an associate lends me a PCMCIA modem (a Gateway Telepath). It works just fine; I don't even have to tell my communications programs about the change. When I get back to the office, the nice folks at Megahertz send me a replacement X-Jack modem, this one with the new "digital line guard" feature to protect it from high-voltage melt down.



Lesson learned: Don't plug your analog modem into a PBX system.

February 2 1995

Northwest Airlines flight 727, Boston to Minneapolis. This plane has seat-back phones that look newer than the ones I tried on United, and they have an encouraging label stuck on them: "This phone modem-compatible." It takes me about 15 minutes to come up with the right combination of access and dialing codes, but it works. I'm doing E-mail from a plane! True, I have wires and credit cards strewn all over the tray table, and I'm spending $2.50 a minute to exchange messages with people who could very well wait another 3 hours to hear from me. But next time I have to dash off a message from the air, I'll know how.

Lesson learned: E-mail from an airplane is expensive and complicated, but on the right airline, it actually works.

February 7 1995

Hyatt Regency, Irvine, California. The phone in my room has a modem jack (a plus), but there's an ominous placard on the desk: "Modem and computer users: For best results, set modem speed to 1200 baud." Sure enough, I can't connect at faster speeds—the hotel's digital phone system apparently compresses the signals and ruins high-speed modem tones. What's worse, the Hyatt's phone charges are outrageous, which means that for every minute I waste running at 1200 bps instead of 9600, I'm spending a fortune.

Lesson learned: Avoid the Hyatt Regency in Irvine.

February 9 1995

San Francisco International Airport, Gate 89. This is the farthest you can get from the Red Carpet Club and still actually be in the airport. Naturally, most of my San Francisco flights leave from here. My flight is delayed for maintenance reasons, but we're advised not to stray from the gate; the plane could board at any minute. Nearby is a futuristic AT&T 2000 pay phone with a keyboard and an inviting little blue RJ-11 jack. I have to try it.

I perch my Dell Latitude on top of the phone and get to work. Half an hour later, after perfecting some carefully orchestrated acrobatics that involve lifting and replacing the handset and pressing the right buttons at the right times, I finally make a connection. Meanwhile, the airplane mechanics are still waiting for a part.

Lesson learned: AT&T 2000 public phones have convenient modem jacks, but using them is decidedly inconvenient.



February 13 1995

Philadelphia airport, USAir terminal, between flights. This place is a dump. The run-down terminal has peeling paint, no coffee shop, no airline club, and none of the magic AT&T 2000 phones. But I've been on airplanes all day, and I have another long flight in front of me. I need my E-mail.

Fortunately, on this trip I'm carrying an Apex Mobile Plus Cellular–compatible modem instead of my Megahertz. I connect it to my Oki 1150 cellular phone and dial up the home office in a snap. This modem interfaces perfectly with the phone and can double as a land-line modem when I'm near a phone jack.

Lesson learned: Cellular modems are a great backup to regular land-line connections.

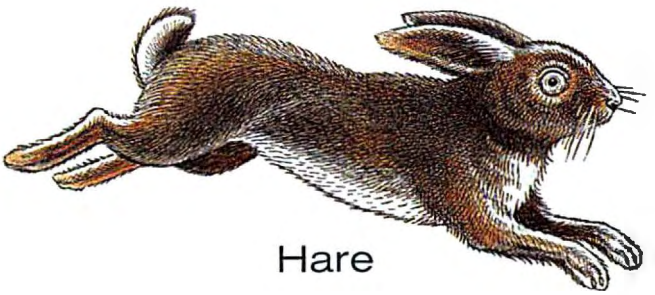
Later that day. USAir flight 2451 from Philly to Burlington, Vermont. This plane has a very intriguing setup: a smallish LCD panel mounted on the seatback and a groovy little phone handset in the seat. In addition to the usual phone keypad, the handset even has an alphanumeric keypad and an RJ-11 jack. But the LCDs are discouragingly blank and the system isn't turned on. When I pull the handset out of its holder, a bright orange wire pulls free of the phone. When I land, I kiss the ground.

Lesson learned: Carry a soldering iron on USAir.

February 15 1995

Jack Daniels Motor Lodge, Peterborough, New Hampshire. I often stay here when I'm working at BYTE's headquarters. But since my last visit, the JD has replaced its phone system with some awful new digital setup. My Megahertz won't function.

Just for kicks, I run back to the office and grab a product I've had for a while: the Konexx Model 111 handset adapter. It installs between the phone's handset and the phone base, and also plugs into my modem. But I still can't get the computer to dial for me; I have to dial the phone manually. It seems that cc:Mail supports manual dialing quite nicely (it sets up everything for you and even flashes a message on the screen reminding you what number to dial), but my other programs don't. I have to enter a new dialing string (ATX1DT) that tells the modem to just pick up the phone and wait for a connection. Then I have to dial all the access numbers myself. Too much work!



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Special Report Mobile Computing

Lesson learned: With the help of flexible comm software, a handset adapter can thwart an innkeeper's nefarious plans to lock you out of his phone system.

March 6 1995

Mulligen, Germany. Several BYTE staffers are staying in a small guest house for the duration of the CeBIT computer show this week in Hannover. There's only a single phone for 17 of us. A bad start to the week.

After examining the guest house's phone wiring, we find that the cable has a completely unfamiliar connection at the wall end, but a somewhat ordinary-looking phone connector at the other (the plug is the same size as an RJ-11, but has six contacts instead of four). I volunteer to try it first.

I plug the phone cable into my modem. The modem's speaker emits a dial tone, but I can't dial out; the switchboard at the guest house doesn't seem to recognize American touch-tone signals. I try old-fashioned pulse dialing. That doesn't work, either.



Luckily, I've planned ahead: There's a Konexx Model 204 acoustic coupler in my travel kit. Remember the old 110-bps acoustic modems from the 1970s? The Konexx works on the same principle, but it uses Velcro straps instead of suction cups to attach its speaker and microphone to the phone handset. The maximum data rate varies, depending on the phone. I got 14,400 bps when I tried it back home on my office phone (an AT&T Merlin), but I'm getting only 2400 bps on the German guest house phones. Still, it works. Soon I retrieve my E-mail, and a line forms behind me for the use of the phone and the coupler.

Lesson learned: Acoustic couplers aren't obsolete. In a pinch, they'll let you get on line from almost anywhere. Worth carrying.

March 8 1995

Hannover, Germany. At the CeBIT show, the BYTE booth has three phone lines: one for voice, one for fax, and one for data. The phones don't have RJ-11 jacks, and the wall has the same odd-looking connectors we encountered at the guest house. Fortunately, a resourceful but guiltless associate has swiped the required cable from a meeting room at a local hotel. (Memo to Hotel Latzen: Please send me the bill; I'll pay up.)

One end of the cable goes into the wall, the other into the modem. Suddenly I'm dialing out with no trouble at all—this phone line even recognizes American touch-tones. The only difference is that the German dial tone is different, so I have to set my modem to "blind dial" (the Hayes command is ATX1).

Lesson learned: It can be advantageous to travel with quick-fingered associates of low moral character.

March 13 1995

Back at my office in Peterborough, New Hampshire. According to my schedule, I'll be in town for two solid weeks. It will be a welcome change of pace. While the traveling is both educational and exciting, my batteries are drained. And that's not just the ones in my laptop.

Final lesson learned: Plug and play is a joke, but if you have the wherewithal, you can get your E-mail from almost anywhere. ■

Raphael Needleman is BYTE's Editor in Chief. You can reach him on BIX or the Internet at rafe@well.com.

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NexGen Chip Challenges Pentium Performance

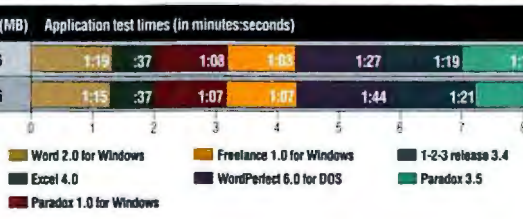
PC WORLD, November 1994

System	CPU	RAM (MB)	Application test times (in minutes:seconds)
Nx586(VL) System	Nx586-P90	16	1:15 :37 1:08 1:03 1:27 1:19 1:16
Pentium System[1]	Pentium-90	16	1:15 :37 1:07 1:07 1:44 1:21 1:16

Shorter times are better.

[1] Average score of six Pentium-90 systems.

Tests run on preproduction unit.
PC World Test Center application benchmarks.



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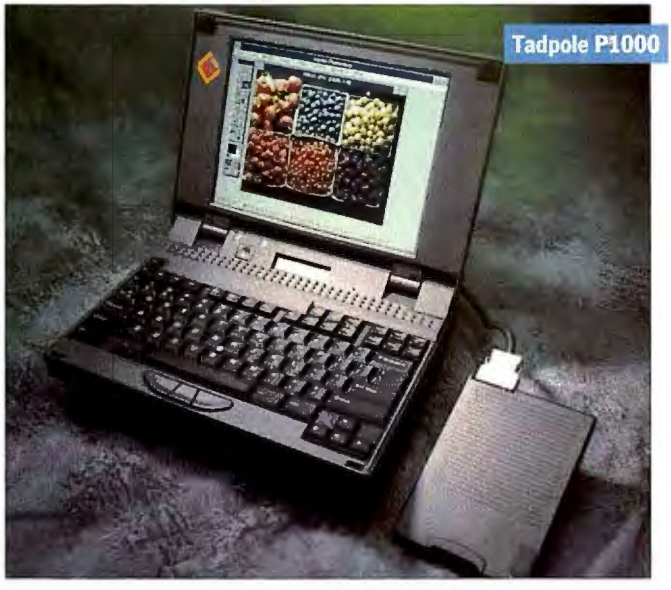
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Red-Hot 100-MHz Portable Pentium

Screaming performance, finicky components

REX BALDAZO

At about the same time that 100-MHz Pentiums are reaching store shelves, Tadpole Technology is introducing a 100-MHz Pentium laptop. Tadpole's P1000 pushes the performance envelope with a factory-upgradable, no-compromise design. When you stretch the leading edge as far as the P1000 does, there are bound to be a few problems. But the result is still pretty sweet.



It's Really Hot

Fellow propeller heads will appreciate the rush we felt when we first powered up the P1000 and it reported 64 MB of RAM. It can hold as much as 128 MB, although the base model ships with a more pedestrian 8 MB. Even if you don't need huge amounts of memory, there's something alluring about a laptop that can handle more RAM than many desktop systems.

For additional expansion, the P1000's PCMCIA slot accepts two Type II or one Type III card. However, it lacks an internal 3½-inch floppy drive; instead, the drive is an external unit, as is the AC power supply.

Our lab tests revealed that the P1000 has prodigious computing power but abysmal battery life. When running the BYTE benchmarks, the P1000 was 110 percent to 120 percent faster than our baseline 90-MHz Pentium desktop system. In our Thumper II word processing test, battery life was a meager 1 hour 11 minutes.

Unlike most laptops, the P1000 has a case that's solidly constructed of magnesium alloy instead of plastic, and it functions as a large heat sink for the cooling system. Small air vents run the length of the case above the keyboard, and flip-down legs at the rear allow air circulation under the unit and also improve the keyboard angle. There are no fans or other active cooling mechanisms. It works well; we ran the P1000 continuously for two days without problems.

However, we recommend that you don't rest the unit directly on your lap. We measured parts of the case at temperatures above 118°F in a room whose ambient temperature was 72°F.

Inside, the P1000's motherboard has a PCI (Peripheral Component Interconnect) bus and a separate daughterboard for the CPU and main memory. Tadpole calls this arrangement the Advanced Notebook Architecture, which lets you upgrade the system by swapping daughterboards. You could switch to a faster x86 processor or even a different CPU architecture, such as a RISC chip. (Tadpole also makes SPARC-based laptops.)

Another sign that Tadpole has designed the P1000 for flexibility is that the pointing device has three buttons instead of two. Windows may need only two buttons, but some flavors of Unix can use all three.

Finicky Floppy

The external components are less flexible. The power supply is fairly small, but the cord that attaches to the computer is too short to reach the floor. It plugs in right next to the external floppy drive, which is also on a short leash.

To save desk space, it is naturally tempting to place the floppy drive atop the power brick—bad move. Electromagnetic fields from the power brick made the floppy drive unreliable for reads and writes. Disk reads were agonizingly slow, and formatting a blank floppy disk was impossible. The interference doesn't appear to cause any permanent damage, however. Separating the power supply and the floppy drive as much as their cords allow returned the floppy drive to normal operation.

Power Users Only

The P1000 is a muscle car among luxury laptops—no refinement, just tons of power. Everything about it says "industrial strength."

So what niche does the P1000 fit? Not a big one, that's for sure. Its short battery life makes it a poor choice for on-the-go work, although an external battery pack is available to extend its unplugged life. It has power to handle the most demanding multimedia applications, but the lack of a built-in CD-ROM drive makes it less than ideal for that purpose.

Instead, the P1000 is aimed at power users. If you need raw Pentium performance that you can tuck under your arm, and price is no object, then the P1000 should be on your short list. ■

Rex Baldazo is a BYTE technical editor. You can reach him on the Internet or BIX at rbaldazo@bix.com.

Performance

BYTE Benchmarks

Integer index:	1.10
Floating-point index:	1.20
Battery life:	
word processing	1.18 hours

(1 = 90-MHz Dell Pentium)

Product Information

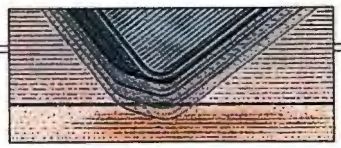
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The Tadpole P1000 is blazingly fast: It ran the BYTE benchmarks 110 percent to 120 percent faster than our baseline 90-MHz Pentium desktop system. And with room for up to 128 MB of RAM, it can handle more memory than many desktop machines.



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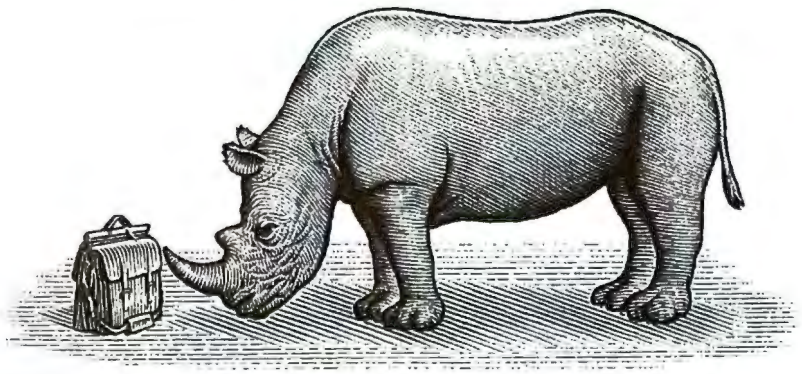
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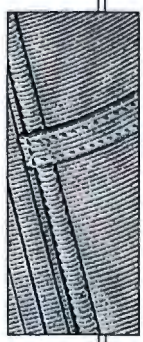
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RISC for the Road

The SparcBook 3XP is a powerful workstation in a small package

DOUG TAMASANIS

If you're looking for a lot of computer in a small box, look no further than Tadpole's SparcBook 3XP. This full-featured mobile workstation boasts an 85-MHz microSPARC II processor, dazzling graphics, built-in stereo sound, a generous array of I/O ports, a removable hard drive, and the popular Solaris operating system.

Cramming all these features into a portable computer doesn't come without a price, however. There's no internal floppy drive, the screen is too small for a multitasking system, battery life is short, and it costs more than most mid-size sport sedans. Despite these drawbacks, the 3XP is a powerful workstation squeezed into a very small package.

Under the Hood

The 7-pound 3XP includes a 340 MB, 520 MB, or 810 MB removable hard drive; up to 128 MB RAM; an internal 14.4-Kbps fax modem; slots for two type I or II or one type III PCMCIA cards; and a three-button pointing stick—all in a magnesium alloy case.

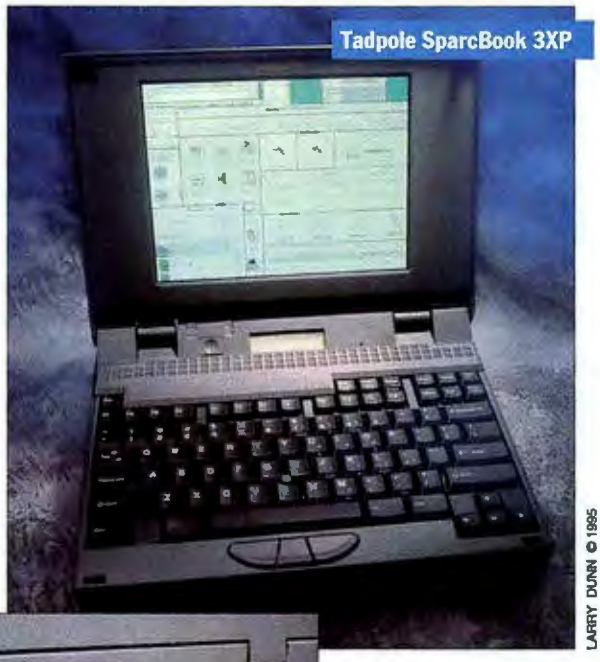
Thanks to a Weitek Power 9100 graphics accelerator and 2 MB of video memory, the 3XP can display 256 colors in two different modes. In native mode, the 3XP supports accelerated graphics at a resolution of 640 by 480 pixels. In virtual mode, graphics are not accelerated, but the resolution is 1280 by 1024 pixels.

The quality of the Sharp active-matrix TFT (thin-film transistor) display is excellent, but a 9.4-inch screen simply isn't large enough for a Unix multitasking environment.

The Test Drive

Installing Solaris and starting up the system for the first time is easy, all you have to do is enter your IP address, time zone, root password and user account information. The entire process takes about half an hour, which is a notable feat by Unix standards. We were disappointed to find that the 3XP doesn't come with any `man` pages or a C compiler.

The keyboard is well laid out and is adequate for short-term use. The right and left Meta keys are not mapped by default, so you must assign them manually with the `xmodmap` command. We found the pointing stick well designed, with the buttons located near the thumb's natural resting position. Pressing the right button is awkward, however.




The Tadpole 3XP RISC-based portable runs Solaris and boasts numerous I/O ports, including SCSI-2 and Ethernet.

An LED display just below the screen indicates the battery's charging status, as well as the activity of network connections and the presence of PCMCIA cards. Under normal use, we averaged only 88 minutes of operating time with the internal battery.

In terms of performance, there is no noticeable difference between the 3XP and a comparable desktop workstation. With its 8-KB data cache and 16-KB instruction cache, the 85-MHz microSPARC II processor achieves a SPECint92 rating of 64 and a SPECfp92 rating of 54.6. In spite of this, the 3XP runs surprisingly cool, never feeling more than warm to the touch even after 10 hours of continuous operation. The battery charger, however, grew quite hot after a 90-minute recharge.

The system software includes a powerful set of system management tools known as the NCE (Nomadic Computing Environment). By far the most useful feature of NCE is its save-and-resume capability. NCE saves the entire contents of main memory in a disk partition, then restores the system to its previous state when you power up again. The whole procedure required about 32 seconds on our 64-MB machine.

One caveat: You can't change the system configuration when the 3XP has been powered down in this manner. You must perform a regular system shutdown to make such changes. Also, we discovered that moving the 3XP during the save procedure can cause an unrecoverable loss of data. In fact, Tadpole advises against moving the 3XP at any time while it's operating; it must first be put into sleep mode. This is an unusual restriction for a portable computer. ■

Doug Tamasanis is a BYTE senior technical editor. You can reach him on the Internet or BIX at dtam@bix.com.

Product Information

SparcBook 3XP.....$12,000
Tadpole Technology, Inc.
Austin, TX
(800) 232-6656
(512) 219-2200
fax: (512) 219-2222
Circle 1005 on Inquiry Card.

Best Feature

The 3XP is well equipped for I/O and includes a 26-pin Ethernet port; 50-pin Fast (10 MBps) SCSI-2; an ISDN port; line-level audio in/out; a stereo headphone jack; two 8-pin RS-232 serial ports; connectors for an external keyboard, mouse, and monitor; and a parallel printer port. Unfortunately, there are no software drivers for the ISDN port.

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9215

Portable Multimedia

Toshiba's Satellite Pro T2150CDT offers almost everything

REX BALDAZO

Usually you have to pay top dollar for premium performance and features. Multimedia laptops with a fast CPU, a good color screen, decent battery life, built-in speakers, and a CD-ROM drive usually cost a king's ransom. But sometimes a manufacturer comes up with a product that strikes a smart balance between power and price.

Toshiba has hit that target with the Satellite Pro T2150CDT. It's not as fast as the highest-end models, and it lacks some desirable features (e.g., video input/output) that are found on other multimedia portables. But it does offer most of the features you'd expect at a very competitive price.

Sights and Sounds

The 6.9-pound Satellite Pro is built on a solid foundation: a 75-MHz 486DX4 processor with 8 MB of RAM (expandable to 32 MB) and a 500-MB internal hard drive. There's also an internal double-speed CD-ROM drive that opens from the right side of the machine. The 3.5-inch floppy drive, however, is an external unit. When it's attached to the left side of the machine, the complete system is rather wide and not well suited to airline tray tables.

The CD-ROM tray can be opened even when the computer is turned off. We're not sure that's a good idea, because the tray might pop open while the machine is stowed for travel. Fortunately, the eject button is recessed to help protect against such accidents.

An internal PCMCIA bay accepts either one Type III or two Type II cards. If you can forgo the external floppy drive, the Satellite Pro becomes exceptionally portable because the AC power supply is built in—there's no heavy power brick to lug around. The only extra piece you need to carry is the power cord. And the whole package still weighs less than 7 pounds.

The 10.4-inch active-matrix screen can display more than 64,000 colors at 640- by 480-pixel resolution. We found the screen very readable, even outdoors on a bright New England winter day. Our only complaint is that it doesn't fold all the way back, so you can't slide it under a monitor stand while working at your desk.



LARRY DUNN © 1995

Stereo sound is built in, but stereo speakers are not—there's just one. For true stereo, you'll have to plug in a pair of external speakers or headphones (not included). A little knob controls the volume of both the headphones and the internal speaker, quite useful when you accidentally start Doom with the sound turned up.

In our Thumper 2 word processing test, we measured battery life at a respectable 5 hours and 12 minutes. For our CD-ROM test, we played Rebel Assault and exhausted the battery after 2 hours and 5 minutes. Unlike IBM's ThinkPad 755CD, the Satellite Pro doesn't have a joystick port, so we had to use the AccuPoint controller on the keyboard instead.

Performance on the BYTE benchmarks met expectations for a 75-MHz 486DX4 (see the table). CD-ROM performance, as tested with the CDStone suite, was on target for a double-speed player.

Luxury Lite

IBM's ThinkPad 755CD costs around $8000. Toshiba's Satellite Pro comes close to matching its features—and even outperforms the ThinkPad in terms of battery life and CD-ROM speed—for about $3000 less. What's the catch?

Making the comparison to sports cars is inevitable: You might buy a Mitsubishi Eclipse because it's affordable and well built, but you can't help lusting after the unreachable Acura NSX. The ThinkPad is a high-end dream machine, a multimedia portable that's refined, well engineered, and loaded with options. If money were no object, the choice would be easy.

But the Satellite Pro T2150CDT offers almost as much for a lot less cash. Toshiba has done an intelligent job of integrating most of the features you'll need in a multimedia laptop without busting your budget. ■

Rex Baldazo is a BYTE technical editor. You can reach him on the Internet or BIX at rbaldazo@bix.com.

Performance

BYTE Benchmarks

Integer index:	0.483349
Floating-point index:	0.271478
CDStone:	2.01
Battery life:	
Word processing:	5.20 hours
CD-ROM:	2.10 hours

(1 = 90-MHz Dell Pentium)

Product Information

Toshiba Satellite Pro T2150CDT
(8 MB of RAM, 500-MB hard drive)
$4899–$5199 (estimated)
Toshiba America
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Circle 1006 on the Inquiry Card.

Best Feature

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Pentium Power Without Sticker Shock

The Eurocom 9600 is well equipped but has a short battery life

DAVE ANDREWS

EuroPak International's Eurocom Model 9600 packages a 90-MHz Pentium with room for extra-large Type IV PCMCIA cards at a relatively affordable price. Multimedia luxuries (e.g., stereo speakers and a CD-ROM drive) are delegated to an optional docking station. The price of the basic notebook is $4450 for a model with 8 MB of RAM and a 10.5-inch active-matrix color screen. You can lower that price by substituting a dual-scan color or monochrome screen.

The Eurocom 9600 offers numerous features that until recently were rare on notebooks. Standard equipment includes a removable 540-MB hard drive (an 810-MB drive is available for an extra $350), an external video port for SVGA graphics (up to 1024 by 768-pixel resolution), an external keyboard port, a built-in microphone (which is located in front of the trackball), input jacks for an external microphone and line-level audio, an output jack for external speakers, a connector for the docking station, and a 16-bit FM sound synthesizer that's compatible with Creative Labs' Sound Blaster Pro 3.1 and the Windows Sound System.

All that's in addition to an ECP/EPP (Extended Capabilities Port/Enhanced Parallel Port), a pair of 16550 UART (universal asynchronous receiver/transmitter) serial ports for high-speed modems, and an extra-large cavity for PCMCIA peripherals. The PCMCIA bay accepts two Type I/II cards or one Type II and one Type III card. It will even take a 15.5-mm Type IV PCMCIA card (e.g., a Global Position Satellite tracking device). Inside the computer, there's room for 40 MB of RAM.

The Eurocom 9600 forgoes the small LCD strip that many notebooks use to display the battery status and other system information. Nor does it have the separate brightness and contrast controls often found near the screen panel. Instead, it uses a Spartan combination of LED indicators and key combinations for these functions. And instead of a Windows applet, it has a ROM-based utility for tweaking the power management options. EuroPak says these features make it easier to install another OS (e.g., OS/2 or Windows NT) in lieu of Windows 3.1.



LARRY DUNN © 1995

A 1-inch (25-mm) trackball positioned in front of the 86-key keyboard is the Eurocom 9600's mouse substitute. The trackball is easy to find and manipulate, but if you have big hands, the keyboard might feel a bit small. I'd definitely like to see a larger space bar.

Despite two NiMH (nickel-metal-hydride) battery packs, the Eurocom 9600 averaged only 1 hour and 28 minutes of battery life in BYTE's Thumper test. (We didn't run the CD-ROM test because there's no built-in CD-ROM drive.) EuroPak plans to introduce notebooks with longer-lasting lithium-ion batteries later this year, including a faster model based on a 100-MHz Pentium.

The Eurocom 9600 uses the 65540 VGA controller from Chips & Technologies, which includes 1 MB of on-board video memory. Unfortunately, EuroPak makes it hard for you to take advantage of the 65540's interesting video-overlay capabilities, because the Eurocom 9600 lacks a video-in port. A EuroPak official says the company hasn't seen a strong demand for integrated video-in-a-window functionality. You could buy a PCMCIA card that takes advantage of the 65540's capabilities or install a video board into the optional docking station.

When running BYTE's portable benchmarks, the Eurocom 9600's performance was comparable to the baseline 90-MHz Pentium system. The Pentium gets a boost from a 256-KB secondary cache of 12-nanosecond SRAM (static RAM). An internal fan keeps the CPU cool. Although the machine becomes fairly warm after running for several hours, you can rest it on your lap without any discomfort. And the system's 6.6-pound weight won't cut off the circulation to your legs.

The Eurocom 9600 continues EuroPak's strategy of providing high-end portable power without requiring you to dig as deeply into your pockets as most of the competition. ■

Dave Andrews is a BYTE news editor. You can reach him on the Internet or BIX at dave.news@bix.com.

Performance

BYTE Benchmarks

Integer index:	0.933050
Floating-point index:	0.921311
Battery life:	
Word processing	1 hour, 28 minutes

(1 = 90-MHz Dell Pentium)

Product Information

Eurocom Model 9600
with a 9.5-inch monochrome screen and a 540-MB hard drive,.....$2850;
with a 10.5-inch dual-scan color screen and a 540-MB hard drive,.....$3450;
with a 10.5-inch active-matrix color screen and a 540-MB hard drive,..$4450
EuroPak International
Nepean, Ontario, Canada
(613) 224-6122
fax: (613) 722-2767
Circle 1146 on Inquiry Card.

Best Feature

The Eurocom 9600 packages 90-MHz Pentium power in a sleek, affordable notebook. It weighs 6.6 pounds.

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Circle 218 on Inquiry Card.

Not Flashier, but Faster

AT&T's Globalyst 250P is good for running heavy-duty applications

DAVE ANDREWS

AT&T's newest high-end notebook, the Globalyst 250P, lacks some of the multimedia amenities offered by IBM's ThinkPad 755CD. However, this notebook undercuts the ThinkPad's high price and delivers superior overall performance, thanks to a 75-MHz Pentium CPU that's matched to a 256-KB secondary cache of fast 12-nanosecond SRAM (static RAM). The 250P did exceptionally well in BYTE's FPU benchmark test while running noticeably cooler than faster notebooks based on 100-MHz Pentiums.

Like all portables, the Globalyst 250P makes some compromises. Its strengths include a 10.4-inch TFT (thin-film transistor) active-matrix color screen, resolutions that are as high as 800 by 600 pixels, better keyboard response than the 486-based Globalysts, and sturdy construction. Weaknesses include a slightly larger girth than other notebooks and an inconveniently positioned trackball.

It has 8 MB of RAM, expandable to 40 MB; a 340-, 540-, or 810-MB hard drive; an internal floppy drive; parallel and serial ports; microphone and headphone jacks; an internal microphone and speaker; an external video port for SVGA graphics at resolutions of up to 1024 by 768 pixels; and PCMCIA slots for two Type I/II cards or one Type III card.

For multimedia presentations, you'll want to plug in external speakers and, if you plan to record a lot of voice-overs, a better microphone. The built-in microphone is highly directional; you've got to speak directly into it.

To maximize battery life, the Globalyst 250P offers a wealth of power management options. You can configure individual subsystems (e.g., the serial port, hard drive, and LCD screen) to power down after a specified period of inactivity; a small LCD panel indicates the battery's remaining charge and the power management configuration. A suspend-mode button shuts down all the subsystems but retains data and system status for about half an hour.

Because of the small size of the suspend-mode button, we could not use the BYTE Lab's Thumper device to test the Globalyst 250P's battery life. However, we ran a variety of software on the machine, including a word processor and audio/video playback applications, and found that the NiMH (nickel-metal-hydride) battery lasted for 2 hours and 45 minutes. If you need a longer battery life, you can replace the floppy drive with a second battery pack. You can also swap the floppy drive for a $230 expansion module that adds two more PCMCIA slots.




Input device preferences are personal, but reviewers found the Globalyst's pointing device awkward to use.

The Globalyst 250P is available with two optional LCD screens: 640 by 480 pixels with 65,536 colors, and 800 by 600 pixels with 256 colors. Both are 10.4-inch TFT active-matrix color LCDs. We tested the notebook with the 800- by 600-pixel screen. This higher resolution makes it easier to work in a GUI environment.

You can adjust the screen for lower resolutions, if you wish. However, if you switch from 800 by 600 pixels to 640 by 480 pixels, the screen image shrinks by an inch on each side. That's because LCD screens, unlike CRT screens, have fixed-size pixels. Switching to a lower resolution results in a smaller screen image, not higher magnification. The unused pixels are simply blacked out.

Weighing 6.9 pounds (plus 1.16 pounds for the battery) and with dimensions of 11.7 by 9.3 by 2.1 inches, the Globalyst 250P is large for a notebook. But the extra size does not necessarily mean a more luxurious working space. For instance, the trackball is positioned at the front of the machine and is perpendicular to the keyboard. You must drop your thumbs below the keyboard when you're mousing around. The Globalyst 250P's strong FPU performance and optional high-resolution screen make it good for heavy-duty number crunching and other FPU-intensive applications. (AT&T says the Pentiums used are free of the FPU bug.) Its multimedia features are adequate for most users, but if you want a lot of flash in your presentations, be prepared to pack extra equipment. ■

Dave Andrews is a BYTE news editor. You can reach him on the Internet or BIX at dave.news@bix.com.

Performance

BYTE Benchmarks

Integer index:	0.836357
Floating-point index:	0.958032

(1 = 90-MHz Dell Pentium)

Product Information

AT&T Globalyst 250P (SVGA version with 8 MB of RAM)
with a 540-MB hard drive....$6074
with an 810-MB hard drive..$6528
AT&T Global Information Solutions
Dayton, OH
(800) 447-1124
(512) 445-5000
Circle 1150 on Inquiry Card.

Best Feature

The Globalyst 250P's 800- by 600-pixel screen makes it easier to switch among several open applications. The unit also turned in strong FPU benchmark performance.

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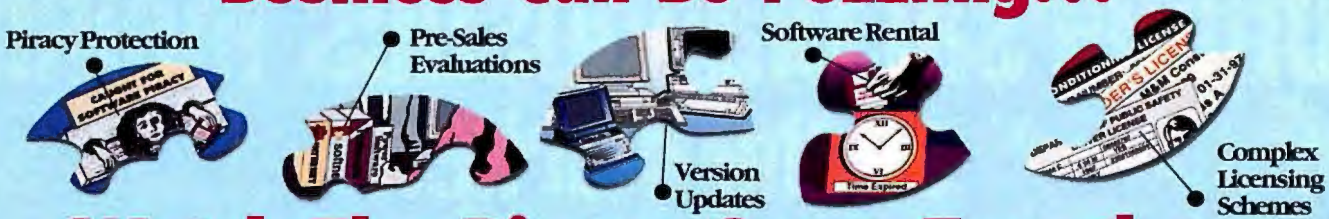
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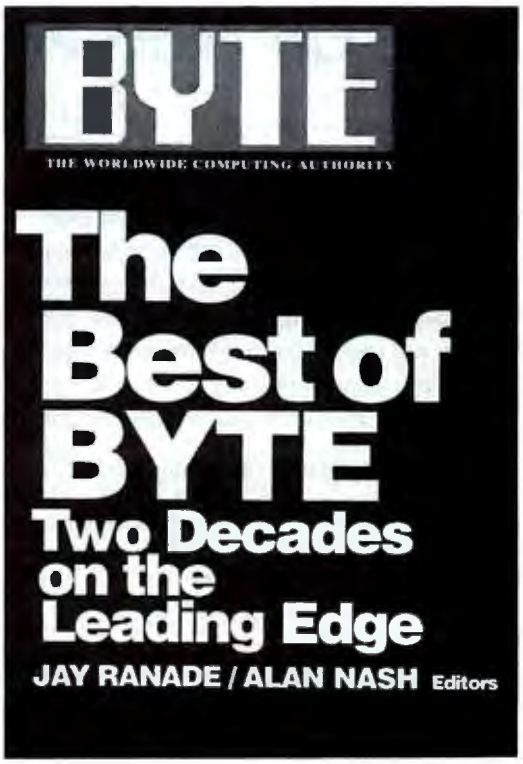
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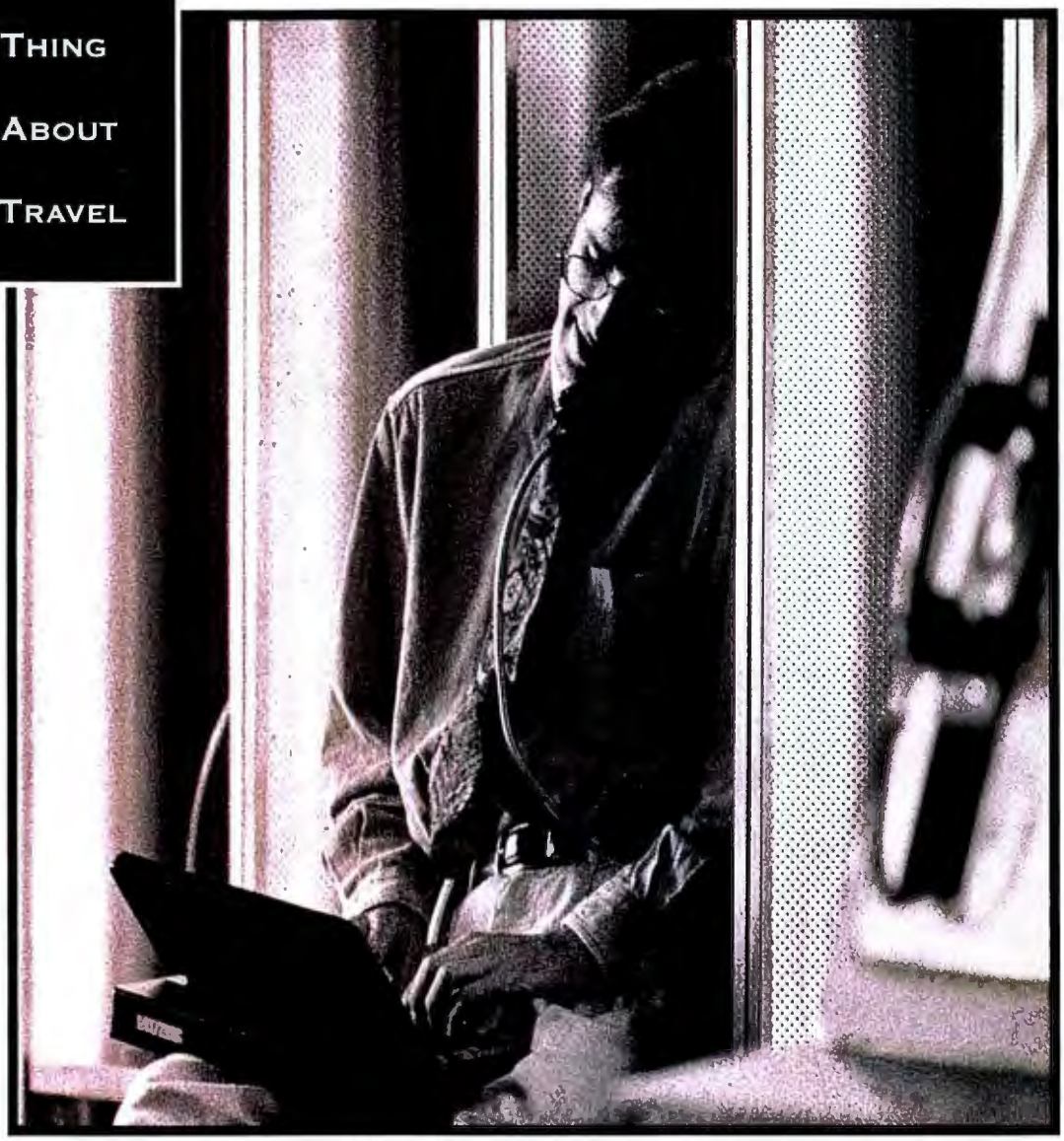
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IMPROVING YOUR MEMORY

We can't remember a time with so many different kinds of RAM to choose from. Here's your field guide to the new chips and what they do.



It used to be simple. You always wanted more memory in your computer, but you had to worry about only one kind—DRAM. The only important differences were in per-chip capacity. While the first IBM PCs in 1981 used 16-Kb chips, today's chips sport 16 Mb. Capacities up to 1 Gb have been announced, but those chips won't ship for a few years.

Memory technologies are so diverse that you can't tell the players without a scorecard. BYTE examines 17 new types of memory chips that embody not trivial distinctions but substantial differences: built-in caches, synchronization, specialized graphics processing, on-chip ALUs, and more. Add in new forms of packaging, and it's hard to keep tabs on what's what.

In "Fast, Smart RAM," Peter Wayner sorts out current and cutting-edge memory technologies. He looks at memory architectures, chips optimized for graphics and video applications, and supercomputer memory. Wayner considers which types of RAM will likely prevail in the marketplace and what will be in your next PC. Related text boxes consider why memory prices stopped falling a few years ago, the reasons flash RAM is here to stay, how the new RAMs affect future cache use and design, and why we're going to see several different types of RAM in a single computer.

"More Memory in Less Space" examines the trend to stacking memory wafers in layers, achieving densities as high as 2 GB per cubic inch. Rick Cook examines the evolution of commodity memory from DIPs to SIMMs and discusses why DIMMs (dual in-line memory modules) will be the norm for the next few years.

Finally, it's worth noting that the memory industry has produced remarkably little in the way of standard-setting activity. It's becoming evident that the marketplace, not an IEEE or ANSI standards committee, will decide which memory chips become the mainstays of tomorrow's computers. This is a two-edged reality. On the one hand, it's fostering the current explosion of exciting new memory technologies; on the other hand, the marketplace is likely to remain fragmented for some time to come. But if we have to choose between encouraging new advances in technology and achieving a more stable commodity market, BYTE thinks it makes sense, especially over the long haul, to bet on ideas, imagination, and innovation. ■

—Russell Kay, Technical Editor

Fast, Smart RAM

RAM chips speed up and get more capable. BYTE helps you sort out the major players from the nonstarters 187

More Memory in Less Space

Layering silicon wafers allows very high-density components 197





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State of the Art

FAST, SMART RAM

Memory chips are getting faster and more capable but not less expensive. BYTE sorts out the new types of RAM—what each is good for, and which ones you're likely to see on your next PC.

PETER WAYNER



BOB DAHM © 1995

Until recently, computer users could proudly wear T-shirts proclaiming, "Whoever dies with the most RAM wins." Complacent in their swivel chairs, they knew that they understood the place of memory in the computer world order.

Now, however, the realm of computer memory is becoming fragmented as RAM producers develop increasingly ingenious methods of squeezing ever more performance out of the chips. Some of their experiments involve on-board caches, specialized CPU-to-RAM interfaces, and even pure processing power directly on the memory chips themselves. Soon a desktop system will be judged on not only how much memory it has but also what architectural enhancements that memory offers to the system.

The force behind these changes has been increasingly apparent over the last decade: RAM-chip speeds have not kept up with the increasing speeds of CPUs. As chip manufacturers found ways to add more transistors to each chip, the CPU architects could easily increase speed by adding more arithmetic units to each chip. Twice as many arithmetic units could let a chip run almost twice as fast. On RAM chips, though, more transistors per chip simply meant that the chips could hold more data; they couldn't access it particularly faster. While faster chips (e.g., static RAM, or SRAM) were available, they were much more expensive and had lower capacity per chip because they required several more transistors to store each bit.

Working around the slow speed of RAM, CPU architects added a small amount of faster cache memory and created separate memory banks that would alternate serving data to the CPU. These techniques, though, are reaching maturity. Intel's P6 includes primary and secondary caches on the main chip die. Many systems augment this by placing a tertiary cache between the processor and the main memory; however,

Flash Memory Looks Bright

Reports of the demise of flash memory have been greatly exaggerated. If sheer storage capacity for laptops is your sole concern, then PCMCIA Type III PC Card hard drives of 260 MB for $600 are attractive alternatives to 40-MB flash memory cards costing $1200. Even flash memory supporters, like Bruno Beverina, vice president of SGS-Thomson's Memory Group, have long maintained that flash memory is "not likely to compete soon with hard disk technology in price and capacity." However, storage capacity isn't everything.

Flash memory cards, with solid-state electronics and no moving parts, require far less power than hard drives, and this is especially significant in perpetually power-hungry laptops. Also, many older laptops simply lack the Type III PC Card slots required for such hard drives, but the more common Type I or II slots fit flash cards just fine. This can be an important consideration if you're outfitting or refitting a whole fleet of laptops. Access times for flash cards (as low as 30 nanoseconds) are from 100 to 1000 times faster than hard drive access times—a performance boost that could end naps between mouse-clicks.

Solid-state flash memory can withstand more serious shocks (some over 2000 Gs) than any hard drive (under 200 Gs), and this is important for ruggedized use in demanding environments. Because flash memory retains information even when the power is turned off, data can be stored without deterioration for time periods reckoned in decades and centuries. Finally, flash memory cards are reliable, with MTBF (mean time between failures) of millions of hours common. For all these reasons, flash memory cards will continue to be important for laptop use.

Flash memory cards are turning up in plenty of products besides laptops. On many printers and print servers, flash cards hold fonts, company logos, complete corporate stationery arrangements, and forms layouts. PDAs (personal digital assistants), including Apple's Newton and other handheld devices, use flash cards as a primary software-distribution medium. Kurt Wolf, divisional marketing manager for AMD's flash memory division, observes that, "In the PDA form factor, flash cards have greater system value than hard drives. You don't need 100 MB; you do need it to be rugged." Hubs and routers from vendors like Xyplex and Madge Networks use the cards to hold software (including compressed microcode) and indispensable unit parameters to support rebooting.

On the chip level, flash memory is even more widespread in computer-related applications. Flash BIOS, once found only in high-end laptops, is routinely replacing ROM BIOS in desktop machines, allowing the manufacturer or user to reprogram the BIOS electronically, without having to replace chips.

The nonvolatile nature of flash memory is also important. Plug-and-Play features will require nonvolatile BIOS memory in which configuration data can be updated. Hubs and routers also use flash chips to replace ROM, guaranteeing the option of simple upgrading. Many modems use flash memory to hold configuration data and software: This lets you upgrade the modem simply and at no cost, by downloading information rather than by swapping chips. Similarly, network adapter cards use flash chips to store the myriad configuration details. On SCSI hard drives, flash chips often hold the control codes that can be customized to satisfy buyer's needs. The reliability of flash memory is not lost on the data security and RAID market: One ruggedized mini-RAID solution from Raymond Engineering eschews hard drives entirely and uses only multiple banks of flash memory.

In noncomputer products, flash memory chips (usually lower capacity) are appearing in cellular phones, pagers, answering machines (replacing DRAM), set-top boxes, and digital cameras. It is simpler to design and manufacture generic cellular phones and configure their flash memory with the specific codes (e.g., GSM, Global System for Mobile communications) appropriate for their final destination, whether that's Germany, Singapore, or Cleveland.

Flash memory plays a similar role in TV set-top boxes, the darlings of the digital convergence cheerleaders: Generic boxes can be customized after manufacture and given special information as needed (and paid for). Even cars use flash memory as part of their engine control systems.

While the flash memory PC Card business is expected to grow at less than 10 percent per year, some predict that the flash memory market as a whole—currently

the gain that each new level of cache produces is substantially smaller, as absolute gains in access speed are offset somewhat by the need to look in yet one more place (see the text box "Is Cache Losing Its Cachet?" on page 191).

This places more pressure on RAM designers to deliver information faster. The latest designs incorporate small quantities of extra logic that organizes the flow of data off the chip. These chips—known by names like FPM (fast page mode), EDO-RAM (extended data out RAM), or burst-mode RAM—offer faster data flow when the data is requested in sequential order.

More exotic alternatives are emerging in the graphics arena, where innovation is more common because the standard unit is the video card, not the SIMM. This lets card manufacturers experiment with and adopt different technologies and still produce a board that works with all software. These card designers are exploring the use of FPM, EDORAM, and burst-mode RAM, and they're also investigating technologies like Mitsubishi Electronics' 3D RAM and Samsung's WRAM (Window RAM), both of which include more circuitry on the RAM chip designed to speed up common video operations. (For more on graphics RAM, see "Faster Graphics Cards on the Horizon," April BYTE.)

Systems designers are beginning to explore a greater range of nonvolatile memory. Flash memory is an electrically alterable memory that maintains its state until it is erased with a relatively large voltage. Originally developed by Intel, flash RAM has seen wide use in PCMCIA PC Card memory for laptop computers. (For an update, see the text box "Flash Memory Looks Bright.") FRAM (ferroelectric RAM), a newer competitor in the nonvolatile arena, uses iron in the fabrication process, an echo of the old ferrite-core memory used in early mainframes. FRAM also maintains its memory after the power stops. Both these memory products should find increasing use in highly portable products like PDAs (personal digital assistants).

In the farthest regions of the intellectual frontier, memory designers are experimenting with memory that can do many computations directly on the chip (see the

about $1 billion—will grow at 50 percent per year, reaching $4 to $10 billion by the year 2000. Several processes are fueling that growth. Ron Bohn, an analyst at Dataquest, sees flash memory as a "technology enabler." Certainly, consumer products using flash memory—like cellular phones—are growing in popularity fast. The price of flash memory is falling, and becoming competitive with DRAM. This causes a curious, if simple, upgrade behavior: People with 10-MB cards wait a year or two and buy a 20-MB card for the same price.

As inevitably happens with electronic technology, flash memory is also becoming a commodity with competing vendors, including powerhouses AMD, Fujitsu, IBM, Intel (the world's leading producer), Matsushita, Mitsubishi, National Semiconductor, Panasonic, SGS-Thomson, and Toshiba, in addition to smaller vendors, such as Centennial and M-Systems. Most flash memory is built to the same standards and is interchangeable: a customer demand that vendors satisfied.

Flash technology itself is moving forward. Single power-supply chips—at lower power—are supplanting dual power supply. Serial interfaces and smaller block sizes allow more flexibility. Wear-leveling algorithms place data evenly over the chip, increasing its durability and reliability. Chip size is shrinking, as the latest generation of 16-Mb (2-MB) chips attest. Look for a doubling of capacity per cell in the next year. Already 40-MB flash cards exceed the capacity of the lowest-end PC Card hard drives. Some people predict hard drive–size flash cards within five years.

—Edmund X. DeJesus

text box "Smart Memory" on page 190). They expect this will offer dramatic performance improvements on problems that can be solved in parallel. Placing the intelligence on the chip saves the time of moving the data on and off the chip.

The RAM Shift

The computer memory industry doesn't jump on these new innovations quickly, because it produces chips in such high volumes. No memory manufacturer can begin to build new formats or innovations until the demand is there, and the demand is not certain until system enhancements become essential.

By the time this article appears, the computer industry will be engaged in a large-scale adoption of EDORAM for main memory. In fact, this year promises to be the one in which EDORAM begins to dominate the marketplace. Many system integrators and RAM manufacturers agree that the price differential that EDORAM commands will evaporate by early 1996.

The technology behind EDORAM is a simple extension of the trend that made FPM RAM the standard form of DRAM available. When you read an element in a DRAM array, you charge electrical lines to first select a row and then a column. The lines do not stabilize immediately, however, and the length of the delay is what prevents the RAM location from being read instantaneously.

FPM RAM returns data faster because it assumes that the next data requested will be in the next column of the same row. In many cases this happens, and there's no need to wait for the row delay. This process stops working reliably, however, if the CPU demands data too quickly. The lines do not stay stable long enough for the CPU to read off the answer. This usually begins to happen in CPUs running at speeds faster than 33 MHz.

To solve this problem, EDORAM adds a set of latches, or secondary memory cells, at the output. These sense the data being fed for output, store it, and keep it available long enough for the signals to reach the CPU reliably. These chips should be stable at system bus speeds up to 50 MHz.

You can add even more circuitry and let EDORAM offer information at still higher speeds. An approach known as burst EDORAM assumes that the CPU wants the next, say, four addresses and begins fetching them automatically. This technique can easily supply systems with a bus clock speed of up to 66 MHz reliably.

The Race Is On

CPUs are getting faster, however, and they demand ever faster memory. Many memory makers are investigating two solutions: synchronous RAM, in which the CPU and RAM are locked together by the same clock; and cache RAM, which gains speed by adding to the chip a small amount of fast SRAM that acts as a cache to the DRAM. Both are good choices for systems that run faster than 66 MHz.

The synchronous solution is a cleaner replacement for the old interfaces between chips. Normally, memory chips answer requests. SDRAM (synchronous DRAM) feeds off the same clock cycle as the CPU, anticipating the CPU's demands and staying in step. Some devices even have a pipelined architecture, in which a stage can fetch an address while other stages present the data for output. Many people predict that 1996 will be the year of SDRAM, because 66-MHz or higher CPUs will be common by then and will need SDRAM. Until then, however, SDRAM will command a 20 percent to 50 percent premium over commodity DRAM. Also, the price of these faster systems must cover the added cost of the different logic chips needed to drive the SDRAM.

Another way to speed memory access is by adding an on-chip cache. This approach, often called CDRAM (cached DRAM) or EDRAM (enhanced DRAM), succeeds because it places an SRAM cache on the same chip as the DRAM. CDRAM comes from Mitsubishi (Sunnyvale, CA) and is second-sourced from Samsung, and EDRAM comes from Ramtron International (Colorado Springs, CO). In both cases, this cache can respond more quickly to requests for the CPU if it has the right information already in the cache.

The chips also gain speed because the caches are able to fetch data from the slow DRAM in large blocks using the internal buses. Mitsubishi's CDRAM, for instance, features a 16-Kb cache with 128-bit lines on both its 4- and 16-Mb chips. When data is requested, the slow DRAM sends the entire 128-bit block to the fast SRAM. If the next address requested is in this block, as often happens, then the chip is ready. Picking the right sizes for the caches and buses is still an art, and practice varies widely. Ramtron, for instance, chooses to use a 2048-bit-

An Abbreviated Guide to the RAMs

CDRAM	cached DRAM
CVRAM	cached VRAM
DRAM	dynamic RAM
EDRAM	enhanced DRAM
EDORAM	extended data out RAM
EDOSRAM	extended data out SRAM
EDOVRAM	extended data out VRAM
FPM	fast page mode
FRAM	ferroelectric RAM
RDRAM	Rambus DRAM
SDRAM	synchronous DRAM
SRAM	static RAM
SVRAM	synchronous VRAM
3D RAM	Matsushita's chip for 3-D video processing
VRAM	video RAM
WRAM	Window RAM

Smart Memory

The most sophisticated approach to squeezing more information out of memory chips is that being taken by Cray Computer (Colorado Springs, CO). Engineers are building a new version of the Cray 3 supercomputer using a special kind of memory that contains embedded processors. Each memory chip comes with 128 Kb of storage and 64 single-bit ALUs that can perform all the basic 1-bit operations. The 1-bit processors embedded on the Cray memory chips each contain three 1-bit registers. Data in any of the local bits of each processor can be loaded into and stored from these registers. Each of the three registers can have two different states, which means there are eight possible configurations for the set of registers. A programmer specifies an instruction for the 1-bit ALUs by presenting an ALU with 1 byte that contains the 1-bit answer to all eight possible configurations. The chips were designed by the Supercomputer Research Center (Bowie, MD) as part of a research program sponsored by the National Security Agency, or NSA. The technology was licensed by both Cray Computer and National Semiconductor, who will be fabricating the chip.

This chip was designed to act like normal memory most of the time. If, however, the main processor wants to use any of the 64 processors scattered throughout the memory, it raises one of the signal lines and effectively writes the instruction to the chip. The instruction is dispersed to the individual processors, each of which executes the instruction on 2048 bits of local data.

The processors have a 1-D shift register for communicating with one another. In many respects, this is the most significant difference between this approach and the classic single-instruction, multiple-processor arrays like the Connection Machine CM-1. Those older machines used complicated 12-dimensional message-passing arrays to route data between processors. This limited the number of processors on each chip simply because there weren't enough pins in a standard package to handle a large 12-dimensional network.

The first computer system using this new memory will be known as the Cray 3/SSS, and the first customer is NSA, which will presumably use it for code breaking. Robert Cox, director of the Cray 3/SSS project, expects that the computer will find many uses in highly parallel problems (e.g., image processing and seismic computation).

Coherent Research (Syracuse, NY), a company that has manufactured and tested similar products, has shown how this specialized memory could be used in graphics accelerators. They produced a demonstration system that would identify which window was hit by a mouse, doing this by testing all the windows in parallel using the processor array embedded in the memory. Such highly parallel applications might be desirable, for instance, in future games that flash many different objects across the screen. With the ability to test for collisions and selection in parallel, game designers could add many objects to the screen without decreasing performance. This high-end memory could also have application in database searches, ray tracing, and other highly parallel problems.

In late March, the preceding was written before Cray Computer filed for Chapter 11 and laid off many employees. Obviously, the immediate future for this particular, and expensive, memory technology is uncertain, but the special demands of supercomputing may yet see it become a commercial reality.

wide bus to fill an 8-Kb SRAM cache on its 4-Mb DRAM.

Some systems designers are happy with cached memory chips. Ocean Information Systems (Covina, CA) manufactures 486 and Pentium motherboards that use Ramtron's EDRAM as the main system memory. The cache on the chips allows all the memory to operate at cache memory speeds. This makes an enormous difference when the CPU requests information that isn't in the L2 (Level 2) cache—something that happens more frequently with multitasking OSes and bloated programs. Barnett Fischer, Ocean's director of R&D, says, "A 100-MHz Pentium runs at only 8 MHz if it misses the L2 cache." That is why a 33-MHz 486 system using EDRAM can switch among a number of tasks much faster than a 100-MHz Pentium with a standard DRAM. The Pentium will still be substantially faster on single-task benchmarks that don't leap outside the L2 cache, but it will crawl to an 8-MHz halt when the cache starts missing.

RAM Packaging

As EDORAM and faster products begin to permeate the market, they will be seen primarily as 72-pin SIMMs, currently the standard commodity configuration for the PC world, although that may not be the best long-term solution. All RAM manufacturers are investigating faster and denser packaging, including direct mounting, wafer laminating, and other ways of packing the wafers closer to each other (see "More Memory in Less Space" on page 197). Many manufacturers are continuing to examine packages that might offer a more stable and faster bus. For instance, SDRAM requires that the RAM and the CPU share clocking information, and more precise packaging may better serve this need.

One of the best-known alternative formats for RAM is RDRAM (Rambus DRAM) from Rambus (Mountain View, CA). This bundles better and smaller packaging with more-stable lines and faster signaling logic. The chips are close together, and the leads are designed to be short, precise, and manufactured to much tighter tolerances than are standard printed circuit boards. This minimizes the extra capacitance that can cause the signals to travel at unpredictable speeds.

The system is also strongly synchronized to a clock that regulates exactly when the information will be available on the bus. The transfer happens every 2 ns on both the odd and the even edge of the clock cycle. This synchronization is similar to the process proposed for SDRAM. All these factors combine to enable transfer speeds up to 500 MBps.

VRAM

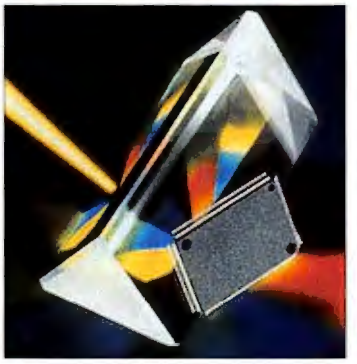
The commodity market for main memory is forced to be conservative and slow-moving because all additional memory usually comes in a standard package. The designers of video boards, however, are free to use whatever types of memory circuits they like, and as a result, the market is filled with many different approaches. Some use commodity DRAMs, others use more specialized VRAMs, and still others experiment with more exotic combinations like WRAM and 3D RAM.

Whether to use DRAM or the more expensive VRAM to maintain an image on the screen is an old debate. DRAM serves one master—the controller, which is responsible for changing the image on the screen and for collecting the information and sending it off to the video monitor. In a video card using VRAM, the memory

chips serve two masters: One maintains and changes the image, while the other gathers the information for the video monitor. The VRAM is constantly serving both masters, each at a different port.

VRAM may have two ports, but that doesn't mean it's twice as fast or can provide twice as much information. The actual individual memory cells are the same in VRAM and DRAM. There's a limit to how much information can be moved in and out of an array of DRAM cells, because the addressing lines for the rows and columns must be charged and discharged. This total throughput volume is known as *bandwidth*. VRAM's dual ports don't double the total bandwidth; they merely reserve a slice for the circuitry that drives the screen-drawing function. This extra port increases the amount of information that can come and go from a chip, but it doesn't double it.

This segregation has two effects. The VRAM circuits always perform better at higher resolutions with more colors. The extra bandwidth helps in these high-end cases, where a 1280- by 960- by 24-bit screen image requires moving over 3 Mb onto the screen every time it is refreshed. But for lower resolutions, there's much less benefit to be gained from added bandwidth. In these low-end video configurations, VRAM's second port is unused much of the time.



Mitsubishi's new 3D RAM memory chip, intended for specialized graphics applications, can determine whether a pixel is hidden, based on its z-value.

On the other hand, DRAM boards have no set restrictions on how the bandwidth is used, and this is precisely why lower-end video-board manufacturers often choose it. Any memory that isn't used to refresh the screen is available for the video controller to use. If a low resolution is chosen for the screen, then the video controller can use the rest of the bandwidth to create complex images on the screen. The downside is that the amount of leftover RAM drops as screen resolution increases. These DRAM boards can display high-resolution images, but manipulating them becomes sluggish.

RAM manufacturers are exploring new RAM chips for video boards in many ways. Caches, synchronization, and latching can

Is Cache Losing Its Cachet?

BY DAVID F. BACON AND PETER WAYNER

Adding cache memory is well recognized by computer buyers as a reasonable way to turbocharge a system's performance. Nowadays, however, the need for separate caches is disappearing as newer microprocessors add more cache directly onto the CPU die itself and as multitasking OSes fragment memory demands and lose much of the performance advantage that cache memory is supposed to provide.

Recent generations of CPU chips have had enough silicon real estate to include a small on-chip cache. These caches have generally been in the range of 8 to 32 KB, which is too small to help many applications. As a result, many computer systems have been built with a larger, off-chip L2 (Level 2) cache to supplement the on-chip L1 cache.

However, on-chip caches are getting larger. Intel's newly announced P6, for example, has 256 KB of on-board L2 cache, while Digital Equipment's Alpha 21164 has 96 KB of on-chip L2 cache memory. With large on-chip caches like these, the complexity and expense of adding an L2 cache to a PC or workstation makes less sense, so we can expect to see fewer of those types of machines in years to come.

Large software packages and multitasking OSes like OS/2 Warp can destroy the value of a cache if it isn't large enough to hold all the code being executed. When the CPU switches between jobs, it can't find the information it needs in the cache, and it must request it from the substantially slower main memory. Users of Microsoft Windows, for example, may notice this effect already when they ask their system to print in the background. Many machines can't keep both the printing code and the Windows code in the cache simultaneously, so the constant switching makes the system run at the slowest memory speeds.

Look for innovations in cache design driven by the growing presence of multiprocessors. Multiprocessors are just beginning to break into the mainstream server market, and with the demands of desktop conferencing and high-end multimedia applications, multiprocessors are likely to become the platform of choice for power users before too long.

Cache design for multiprocessors is considerably more complicated. If processor A wishes to update a memory location cached by processor B, B's copy must be either invalidated or updated by A. Even worse, if B has already modified its copy, then before A can proceed, B's data must be either flushed back to main memory or transmitted directly to processor A. So far, we've seen two different approaches to solving this. Either all the processors monitor all the memory traffic, looking for potential conflicts with their locally cached data (a snoopy cache), or the main memory controller keeps track of which processors have cached which memory locations (a "directory-based" cache).

Each scheme has its advantages and disadvantages. Snoopy caches are generally easier to implement, but they require that all memory traffic goes over a shared bus. Directory-based caches require extra memory to keep track of the outstanding copies, but they can be used with more sophisticated processor-interconnection networks that provide higher bandwidth and scale to a larger number of processors.

Multiprocessor systems have been the subject of research for the past 30 years, but it's only in the last five or 10 years that they have managed to capture a significant portion of the high-end supercomputing market. Now, as multiprocessors make their way into the high-volume PC and workstation businesses, that research will come face-to-face with the real world.

One Machine, Many RAMs

BY RICK COOK

During the next few years, our desktop computers may well use three or more different kinds of RAM, each chosen for a specific function. For example, a system might use fast, synchronous SRAMs for secondary or tertiary cache, an advanced asynchronous DRAM (e.g., enhanced DRAM, or EDRAM; or extended data out RAM, or EDORAM) for main memory, and RDRAM (Rambus DRAM) or WRAM (Window RAM) on the video card. And yes, you'll be able to plug a PC Card with flash RAM into it, too.

This will be a logical outgrowth of efforts to tune systems for maximum performance. In the old days, if you wanted a faster computer, you used a faster processor running at a higher clock speed. Today, however, designers need to carefully balance every subsystem to prevent bottlenecks. Since different types of RAM have different strengths, it makes engineering sense and, increasingly, economic sense to incorporate several types of memory into a single computer.

As the DRAM market fragments in a shower of new technologies, standards and standards-setting organizations are hardly involved at all. One of the earliest memory standards efforts, IEEE's 1596.4 (called RamLink), is stalled; no products have yet appeared and none are likely to appear for years, says Steven Przybylski, a consultant specializing in DRAM technology. And while synchronous DRAMs are covered by a JEDEC (Joint Electronic Device Engineering Council) standard, says Przybylski, it's incomplete, and synchronous parts from different manufacturers don't always work together. At the same time, however, the proprietary RDRAM technology has become one of the most standardized because its developer, Rambus (Mountain View, CA), has required compatibility from all its licensees.

Therefore, we're not likely to see a single DRAM standard again; instead, we'll have several de facto standards, each optimized for a particular kind of product or application in a classic commodity market. There's still a lot of shaking out going on among these exotic RAM technologies, with competing approaches for nearly every niche.

We can see the effects of competition in the VRAM area. Until recently, dual-ported VRAMs were as much as twice the price of the equivalent DRAM. That led many analysts to predict that VRAM use would drop over the next several years as less expensive fast RAM technologies appeared. Instead, the price of VRAMs has dropped to the point that they're now competitive with the new DRAMs.

Another important factor driving memory in many directions is the considerable pressure to deliver more memory bandwidth. For the workstation market, RAM and computer designers are concerned about how they'll meet the needs of emerging 300-MHz, 300-SPECmark computer systems. A DRAM technology that's well suited for fast video might not be ideal for main memory. For example, Rambus does well in video applications because it's so good at handling burst data in memories of a few megabytes. Unfortunately, those same characteristics make it a less appropriate choice for the main RAM of a fast, general-purpose computer.

The result is a chicken-and-egg proposition. Everyone agrees we're going to need a lot more bandwidth in main memory quickly. But companies are reluctant to commit to a technology until a clear winner emerges, and that won't happen until one technology starts getting a lot of design wins. So in the end, rather than leaping directly to a new architecture for main memory, systems makers will probably proceed cautiously and incrementally.

In time, the DRAM market will probably come back to standardized, commodity parts available from many sources, and we'll once again buy primarily on price. However, that won't happen overnight. For the next several years, we're all going to have to be careful whenever we buy memory for our systems. Different computers may use very different RAM technologies, and it's inevitable that some systems will require specific parts from specific manufacturers. This isn't a pleasant prospect, but it's the price we'll have to pay for increased memory performance and capacity.

Rick Cook is a freelance writer living in Phoenix, Arizona. He can be reached on the Internet or BIX at rcook@bix.com.

all be used to increase the speed of the RAM on video boards. EDORAM, CDRAM, SDRAM, and other DRAM enhancements can be substituted on the board quickly and effectively. In addition, the same techniques can enhance dual-ported VRAM, which means we will see CVRAM (cached VRAM), SVRAM (synchronous VRAM), and EDOVRAM. Burst modes will also be increasingly common because video applications move large blocks of memory more often than many regular applications do.

Adding Intelligence to Video

Enhancing VRAM with caching and anticipatory bursting is just the beginning. There are many standard jobs for a video card that can be sped up by adding some extra intelligence to the RAM chip. WRAM technology is a good example of a dual-ported memory that also has added features for graphics. Matrox (Dorval, Quebec, Canada) is one company using WRAM memory in its video boards. (By the way, WRAM was named more for its ability to offer full-motion video than for any ability to speed up a Microsoft Windows operating environment.) The extra intelligence lets the chip do two-color pattern fills and aligned BitBlts at substantially improved speeds. Matrox engineer Dan Wood, responsible for analyzing the performance of memory chips, points out that these extra features let WRAM perform better than VRAM and at a lower cost.

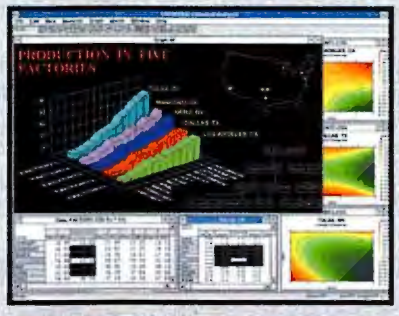
The fast BitBlt is an effect that can be useful for double-buffering fast animation. WRAM can provide this effect only if the start and finish of the Blt are properly aligned. This is because the WRAM achieves the speedup by using its own internal bit bus. The information leaves a memory line and then is written to another line without leaving the chip. This helps accelerate animation, but it won't help with many of the random BitBlts that are needed to open a menu or drag a window across the screen.

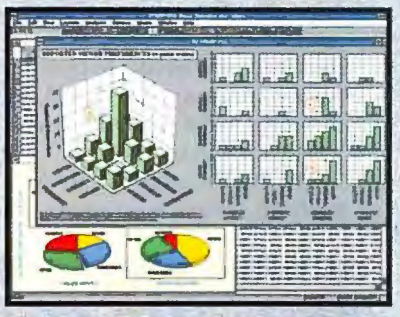
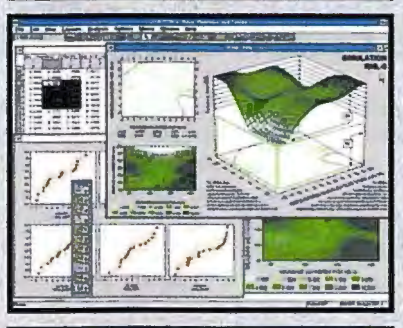
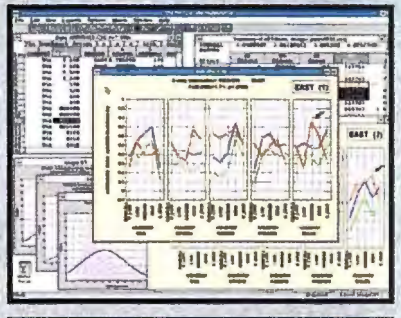
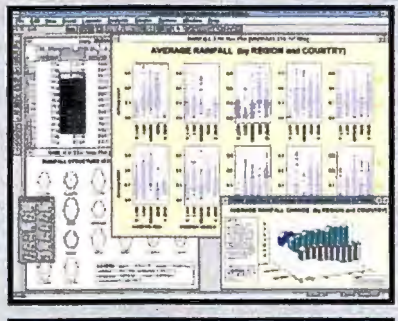
Another intriguing solution is 3D RAM, created by Mitsubishi and Sun Microsystems (Mountain View, CA) to improve the performance of 3-D operations. The solution embeds much of the logic for z-buffering into the chip. Normally, a 3-D graphics card will draw a pixel in 3-D by looking up the pixel in the z-buffer, which stores the z coordinate of the last pixel drawn at this location. If the new z coordinate is smaller, then the pixel under consideration is closer to the eye and thus visible. The graphics card will then write this pixel

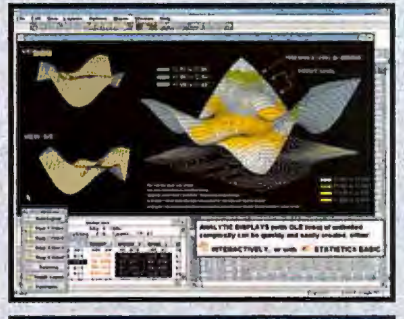
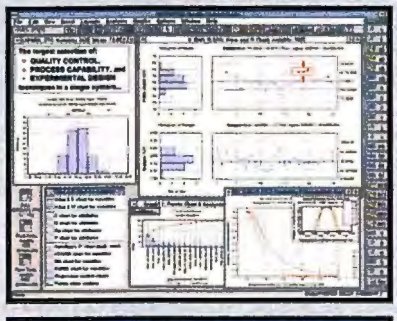
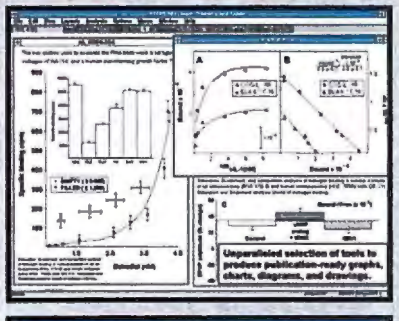
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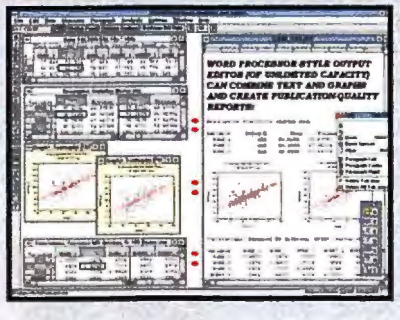
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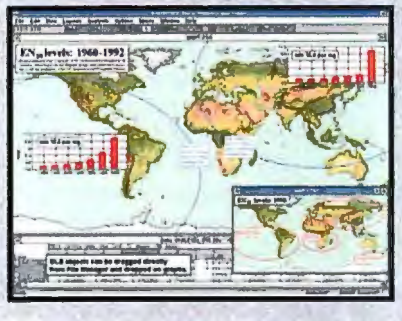






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Circle 91 on Inquiry Card.

back to memory for eventual display. If the z coordinate is greater than this new pixel, the previously drawn pixel would hide it; thus, it is forgotten.

The 3D RAM moves this whole operation onto the memory chip, where it's handled by an on-board ALU. Instead of the video card having to read, think, and write to draw a pixel in 3-D, it just has to write it to the 3D RAM, which decides whether it will be visible.

The ALU on the 3D RAM can also perform several operations, including raster operations, alpha blending, and comparisons. Mitsubishi estimates that a video card with 3D RAM can render about 1.8 million 100-pixel polygons per second—an amount that they claim is nine times faster than a board equipped with VRAM.

The 3D RAM also makes significant use of cache technology. The basic 3D RAM is a 10-Mb chip with four 2.5-Mb arrays that feed one central ALU, which performs the raster operations on the incoming pixels. There is one L1 cache at the ALU and four L2 caches at each of the four banks.

Nonvolatile Memory

In several ways, the market for portable computers is limited only by the availability of power for these machines. This distinction is not lost on RAM designers, who are exploring the use of nonvolatile flash RAM and ferroelectric RAM for the main memory of these machines.

Intel (Santa Clara, CA) is a big backer of flash memory, a technology that is similar to EEPROMs. The chips remember their data until they are hit by a larger voltage. Intel announced a 2-MB embedded flash-memory chip in late 1994. It hopes the chip will find acceptance among printer manufacturers who often need local storage for about 8 MB of flexible information on fonts and other display code.

Flash RAM chips have also found homes in portable, digital cameras and other products that need relatively small amounts of data. Some computer manufacturers are using the chips as a flexible BIOS store that you can upgrade if necessary. But greater acceptance is slowed by the relatively high cost of flash RAM.

Other companies are rapidly entering the race to develop ferroelectric RAM chips, which some people are calling the "ultimate memory." Hitachi and Ramtron are joined in one partnership, and Matsushita and Symetrix (Colorado Springs, CO) are working together in another. All are exploring building 256-Kb and 1- and 4-Mb devices for more-widespread use. Some industry observers expect that FRAM may prove to be a replacement for standard DRAM because it does not seem to degrade after a number of write operations. Flash memory wears out, which limits its usefulness to jobs that do not write data that often. If these companies succeed in developing chips that hold a significant density (16-Mb chips have just been announced), then FRAM may start replacing DRAM.

RAM Drives Forward

The RAM industry will continue to expand and flourish in the next decade—in part because it must. RAM is often the slowest part of today's computer systems, so designers will continue to concentrate on developing faster storage. The expanding market also leads to a greater variety of RAM products with different performance characteristics.

The most exotic memory won't just

Why RAM Prices Stay High

Three things used to be certain: death, taxes, and the announcement of a newer, faster, and cheaper computer two days after you buy one. Innovation continues to produce faster CPUs and less expensive hard drives, but the market for memory seems to have stalled. For several years now, 1-MB DRAM SIMMs have cost between $30 and $40. What happened to the steady drop in price per megabyte that we became so accustomed to?

The problem isn't in the labs. RAM manufacturers are making 16-, 64-, and 256-Mb chips. Both Hitachi and NEC recently announced success in developing a 1-Gb RAM chip. But those chips won't be available in quantities until the year 2002, and their rivals call these announcements a public relations move. Nevertheless, the research scientists continue to produce a new generation of RAM chips about every three years. But we're not seeing this research success translate into commensurate price drops.

The problem seems to lie with the CPU and software industries, where relentless competition has created an unexpectedly large and continuing demand for RAM. This demand continues to exceed supply, as people clamor for new machines running software that can't function without 8 MB of memory.

Multitasking OSes like OS/2, video games, and multimedia all need as much RAM as possible to function. Newer RISC chips such as the IBM/Apple/Motorola PowerPC add to the demand for more RAM, because the native object code for these RISC chips can be 30 percent to 40 percent larger than the corresponding code for the older 680x0 Macintoshes. One Intel engineer took credit for the problem, saying that his company's relentless price-cutting and innovation made high-end CPUs with high-end memory requirements available to the masses. As long as the demand continues to soar beyond capacity, the RAM companies keep the price high and pocket the profits.

This high demand slows the adoption of new technology in two ways. First, RAM manufacturers have no need to push the newer 16-, 64-, and 256-Mb chips because they're making enough money on the smaller chips.

Second, systems designers often skimp on memory to bring the price of complete systems down to bargain rates. 64-Mb chips produce 16-MB SIMMs, and their use forces many systems manufacturers to produce computers with a minimum of 32 MB of memory. The lower demand for these large configurations slows demand for the bigger chips, and that, in turn, slows the evolution. At the moment, computer manufacturers are more likely to push 4-MB machines with a lower initial cost, even though people may be frustrated when they try to run new memory-hungry applications on them.

The only solution will be to equalize the supply. The high profits give the industry plenty of money to invest in new fabrication facilities, and there's plenty of evidence that new capacity will emerge. When this happens, increased competition will again drive manufacturers to greater innovation in their efforts to gain market share. Then, and probably only then, will we see prices start dropping again. Maybe we should try to talk Microsoft into investing in a RAM fabrication plant?

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keep data around; it will compute with it as well. The most ambitious plans for memory will continue to emerge from the graphics arena, but it may not be long before high-end workstations begin to exploit smart memory for general purposes. You can now find on desktop machines, for example, many of the innovations that Cray Computer produced in the 1980s. The smart memory that Cray is using for its latest machines may prove to be another approach that wins over machines in the years ahead. Until that happens, the relatively gentle progression of faster and faster types of DRAM will provide systems designers with plenty of options when they integrate memory. ■

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URGENT—YOUR INPUT NEEDED

On: CPUS

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To improve BYTE's coverage of technology in the State of the Art section, we'd like to get your feedback about what topics, areas, and products we should be considering, and in what ways. Later this year, we plan to look at CPUs—the latest developments in RISC processors, Pentium and P6 CPUs from Intel, and PowerPC chips from IBM/Apple/Motorola. We'll examine where CPU architectures are heading; what effects the move to smaller fabrication technologies will have on chip design, yield, and costs; what these trends will mean to you; and how the chips will work in your future systems.

But we'd like you to tell us what you want to see us report on and analyze. Are you interested in support chip sets, low-voltage processors, or increased on-chip caches, for example? We want to find out about concerns that we may not fully appreciate and just what aspect of CPUs you're interested in. Also, we'd appreciate your help in identifying the people we should be talking to—users, vendors, researchers—you tell us.

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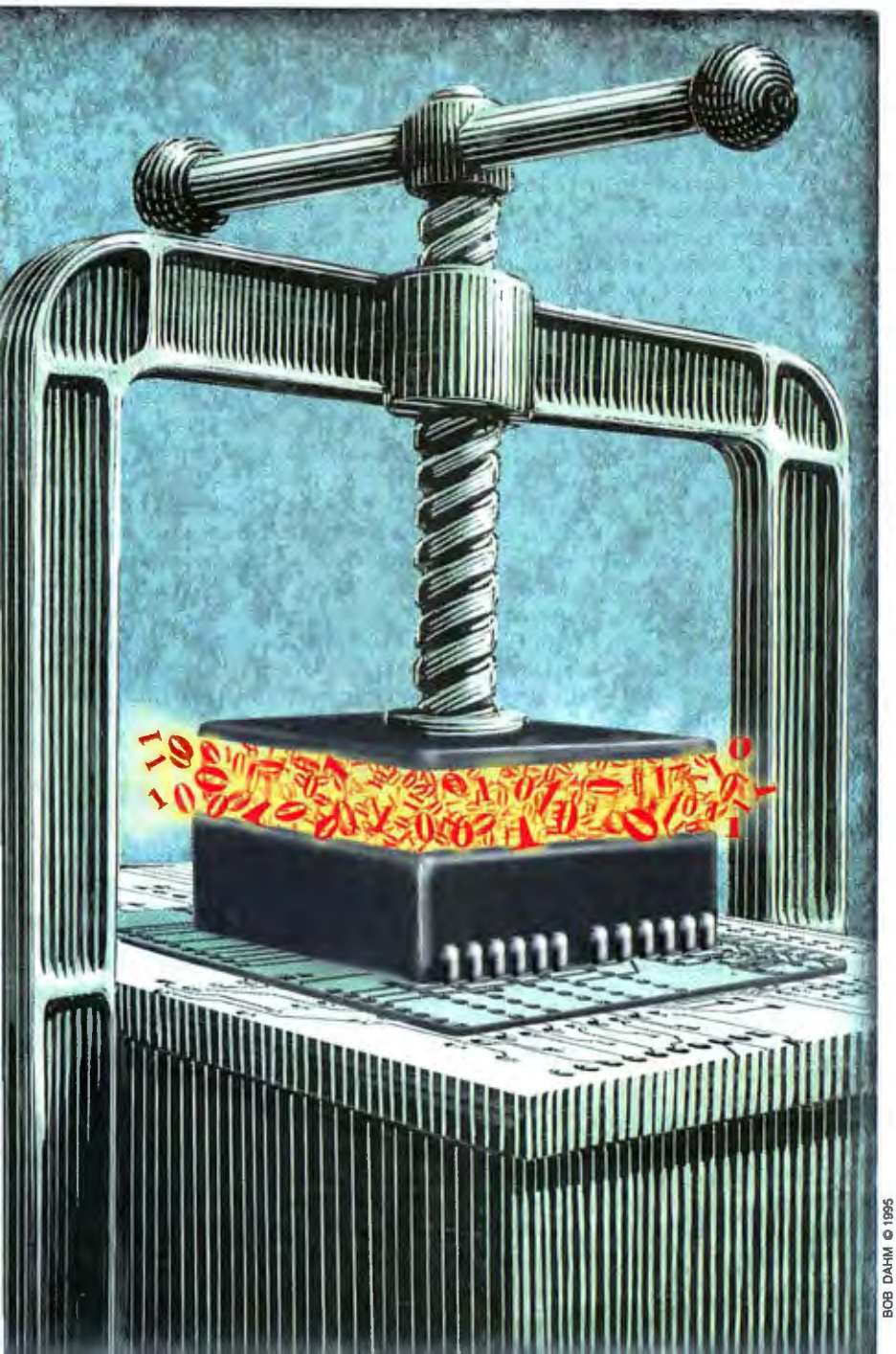
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State of the Art

MORE MEMORY IN LESS SPACE

Innovative packaging techniques squeeze more RAM into tighter spaces

RICK COOK



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Unless you're trying to upgrade a laptop, you don't generally think about how the memory for computers is physically packaged. But computer makers care a great deal about memory packaging. Computers, especially notebooks, are shrinking at the same time that memory requirements are rapidly escalating. Memory-hogging OSes like Windows NT and OS/2 are running memory-hungry graphics-oriented applications.

The market-research firm Dataquest (San Jose, CA) says the amount of DRAM found in the average business computer has grown from 4 MB in 1993 to 16 MB today. It will jump to 24 MB by 1997. Dataquest found that computer makers, trying to hold down prices in a fiercely competitive market, are shipping most systems with just enough memory for the basics—typically 8 MB. But customers know that isn't enough, and they're doubling the memory—often before leaving the store.

Dataquest memory analyst Ron Bohn says, "Companies try to ship with as little memory as they can without losing sales and while retaining quality." Herein lies the second part of the memory-packaging challenge: not just to cram more memory into smaller boxes but to do it in a way that allows users to add even more memory later on.

Skyscraper RAM

In early personal computers, RAM came in the form of DIP (dual in-line pin) chips—those little black centipedes with the silvery legs so beloved of experimenters and kit builders—that were soldered or socketed onto the motherboard. Later on, these chips were installed vertically onto small circuit boards that took up less space. While there's still plenty of life left in the SIMM format and its emerging successor, DIMM (dual in-line memory module), there's still real estate above those packages waiting to be grabbed. In an exciting

More Memory in Less Space



This 128-MB 3-D module from Cubic Memory is surrounded by the 64 separate 16-Mb DRAM chips it replaces.

shift, several companies have announced memory-packaging technologies that take advantage of this third dimension by stacking memory chips closely on top of one another.

Among the companies that have announced 3-D memory modules are Cubic Memory, Staktek, and Dense-Pac Microsystems. A number of other companies, including Intel, Hitachi, and Texas Instruments, reportedly have development projects under way for 3-D modules. (Let's clarify one point of terminology: 3-D has two distinctly different meanings in relation to RAM chips. The various technologies for stacking or layering wafers are generally called 3-D, referring to a physical construction. Matsushita, however, uses the name 3D RAM for its specialized graphics-oriented memory chip, referring to what it's used for. The 3-D memory modules discussed in this article are 3-D in form, not function.)

Memory stacking has been tried before, albeit more crudely, by several companies that piggybacked several DIP chips into a single package. But all those early attempts, such as the 512-Kb modules on the first IBM ATs, used ICs that were already packaged. More recently, some companies have made special 3-D memory modules for such low-volume, high-cost applications as defense and aerospace. The newest generation of memory modules puts naked chips—bare silicon—into special packages. The thinness of the silicon wafers means you can cram more of them together, and maybe even at a competitive price.

The packaging potential of these new techniques is awesome. Staktek's Ribcage Stakpak DRAM module gets 16 MB into a volume of one-eighth of a cubic inch. Cubic Memory does even better, packing up to 2 GB of DRAM per cubic inch in its 3-D modules. That kind of packaging density promises even smaller systems and even larger memory capacities in workstations and servers.



Two 3-D memory modules from Staktek. At the left, the Ribcage Stakpak incorporates 16 MB of fast page mode DRAM in a package that's only 0.5 inch wide, 0.9 inch high, and 0.3 inch thick. At the right is the newer, less expensive Uniframe Stakpak module.

Ingenious as they are, 3-D memory modules pose some special problems for their creators. For example, to make the most of them, you need more address lines from the module to the motherboard than a standard SIMM or DIMM provides. That means a nonstandard motherboard layout, which in turn implies proprietary packaging. The small computer market has shown a considerable aversion to proprietary hardware, but the advantages of 3-D modules are so compelling that many computer makers have announced plans to use them.

While heat is a definite problem with logic chips (remember the first 5-V Pentiums that introduced us to the fan-on-a-chip?), it's a lot easier to handle in DRAM. Nonetheless, 3-D module makers take care to ensure adequate cooling via ventilation ribs and by using signal leads to conduct away heat.

Staktek has been building 3-D memory modules since 1992 and has patented several packaging techniques. Staktek's products use either standard memory dies or TSOPs (thin small outline packages) in thin plastic-leaded packages with an external metal mounting structure that provides both heat and signal transfer. To make clear that its technology is strictly a matter of packaging, the company's Stakpak products are available with flash RAM, up to 256 MB per module; DRAM, up to 128 MB; or SRAM (static RAM), up to 32 MB.

Cubic Memory is one of the most active companies making 3-D memory modules. Its process stacks DRAM chips that have gold wires running to the wafer edges. They are then interconnected by a conductive silver epoxy (see the figure "Wafer Stacking" on page 200). Cubic Memory is building 64-MB SIMMs for the 100-MHz Pentium-based laptop from Tadpole (Austin, TX), as well as other modules for Tadpole's SparcBook 3. For the Pentium model, Tadpole wanted to fit 128 MB of memory in just two SIMM slots. Panasonic is another Cubic Memory customer, offering a 32-MB DRAM PC Card for its notebook computers.

Clearly, 3-D modules will carry a price premium for some time to come. Cubic Memory claims that its devices cost only slightly more than conventional packaging—$44 to $56 per megabyte, compared to $35 to $45 per megabyte for standard SIMMs, according to its president Chet Brown—but the difference is real and will matter to most computer makers. That extra cost will probably limit the use of 3-D modules to situations where space is especially tight and memory requirements are particularly high. It's no accident that Tadpole is using the modules in high-performance notebooks.

However, not everyone thinks that 3-D modules need be costly. Staktek recently introduced a lower-cost package it calls the Uniframe Stakpak. According to James Cady, executive vice president for engineering, the Uniframe DRAM modules are available in OEM production volumes for under $35 per megabyte now, and they should be under $25 by the end of the year.

At the high end of the computing spectrum, Cray Research is shipping its T90 supercomputers with SRAM stacks. Forty 4-Mb SRAM chips are soldered between two printed circuit boards to provide a dense stack. Each memory module includes 16 stacks. Such dense packaging lowers the distance that signals must travel and stabilizes the capacitance of the signal lines. An expensive technology, it's well suited to supercomputer applications—computation-intensive operations that need massive amounts of memory. (For more on supercomputing, see "The Grand Challenges," February BYTE.)

The Old Reliables

When DIP chips lost out in the memory wars long ago, they were replaced first by the SIPP (single in-line pin package) and later by the SIMM, a module designed for DRAM in computers (and other applications) that is today's de facto standard for desktop computers. Essentially, a SIMM (and also a DIMM) is a small printed circuit board holding several DRAMs that plugs into a socket on the motherboard.

Perhaps the most obvious thing about SIMMs is that they stand sideways—perpendicular to the motherboard. This has two clear advantages: It saves motherboard real estate and permits better air circulation around the chips. Also, the modules are easier to handle than memory chips. Thus, nearly anyone can install them.

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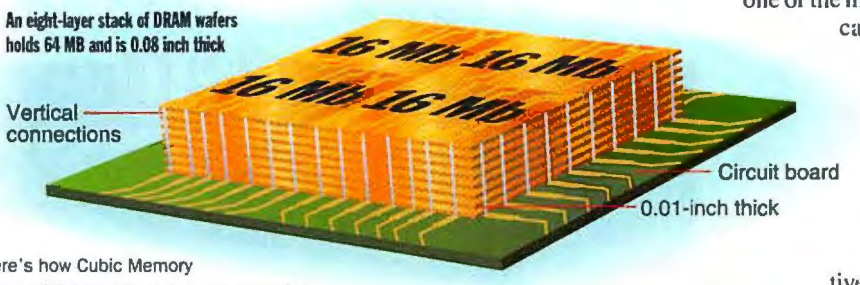
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More Memory in Less Space

SIMMs come in two flavors: 30- and 72-pin. The 30-pin SIMMs use 8-bit DRAMs, and the 72-pin SIMMs use 16- or 32-bit parts. Generally, it takes four 8-bit SIMMs to give the same capacity as one 32-bit SIMM. There is also the matter of organization. SIMMs are usually set up to read 8, 9, 32, or 36 bits at a time. The 9- and 36-bit SIMMs include an extra bit per byte for parity checking. If your computer expects parity memory and you add nonparity SIMMs, the machine won't recognize the extra memory.

Wafer Stacking



Here's how Cubic Memory layers DRAM wafers into a high-density silicon stack.

In practice, this is less of a problem than it appears. While there is a rampant proliferation of part numbers, there are relatively few kinds of SIMMs out there. According to David Sun, vice president of engineering at Kingston Technology (Fountain Valley, CA), the many part numbers actually simplify the situation for users, letting them order memory by computer make and model rather than having to know the specifications of the memory modules.

One result of the wide adoption of SIMMs is that add-on memory boards, once quite popular, are much less common today. Kingston, one of the biggest aftermarket memory suppliers, lists over 1000 memory modules but only 107 memory boards in its catalog, and just 13 memory-chip upgrades for computers.

Of course, the downside to memory modules is that you are limited to whatever kind of memory modules the manufacturer decided to support in whatever quantity the company decided to support them. An upgrader also must make sure he or she has the correct module for the system.

DIMMs Brighten

SIMMs are now giving way to DIMMs, which can pack twice as much memory into the same space. They achieve this by mounting DRAMs on both sides of the module and by using two sets of contacts, one on each side of the module board (SIMMs use only one set).

According to In-Stat, a Scottsdale, Arizona, semiconductor consulting firm, SIMMs should account for 82 percent of the small computer memory market this year. By 1998, however, their market share will drop to 39 percent, and most of the rest will be DIMMs.

DIMMs are more expensive than SIMMs of the same speed and capacity, but manufacturers and analysts expect this to change as DIMM volumes overtake SIMMs. In-Stat analyst Connie Batchelder says that in the long run costs will be the same.

Is 3-D Memory in Your Future?

For all its technological ingenuity, not everyone is convinced that 3-D packaging is the way to go, at least not in the short term. Kingston's Sun says that 3-D modules are basically a way of getting a half-generation advance on new memory chips—say, from the current 16-Mb chips to the equivalent of 64-Mb chips. The problem that 3-D modules solve, Sun continues, is only temporary. When the higher-capacity part becomes more widely available, it automatically takes over from the inherently more expensive 3-D module.

Sun says that Kingston looked into developing its own 3-D module a few years ago, wanting to create a 16-MB SIMM equivalent out of 4-MB chips. In addition to the extra cost and limited life span, he says that a major deterrent was that Kingston would have to buy memory wafers from one of the major DRAM fabricators. But once the higher-capacity chips became widely available, the DRAM supplier would have no economic incentive to cut into the sales of regular DRAM by selling the smaller wafer.

Still, Sun admits that 3-D modules have their place in systems where space is extremely tight and the manufacturer must pack in a lot of memory. He suggests that 3-D modules might make good sense in a PDA (personal digital assistant) or a graphics workstation doing high-end animation work.

But they may see even broader use in the future. The primary argument against 3-D modules is that the next generation of DRAMs will be along fairly soon, which will quadruple capacity per chip at the same or lower cost per megabit. This is based on historical trends, but this extrapolation is no longer a sure thing. And if the progression does break down, alternative solutions such as 3-D modules could become the new standard for memory modules. (For more on why the market hasn't yet seen higher-capacity DRAMs—and may not see them for a while—see the text box "Why RAM Prices Stay High" in the article "Fast, Smart RAM" on page 194.)

More in Less

Although we can't be sure what technology they will use, we can be absolutely certain that computer makers and users will pack more and more memory into computers at an increasing pace. What is ample at one point in time turns out to be unacceptable in a year or two.

Today's notebook computers can already use amounts of RAM that were unheard of in mainframes even 20 years ago, and they need every bit of the RAM they have to support modern applications and OSes. There's no reason to think that our memory requirements will diminish in the foreseeable future, so it looks like we're each going to need a lot more RAM in our computers just to see the century out. ■

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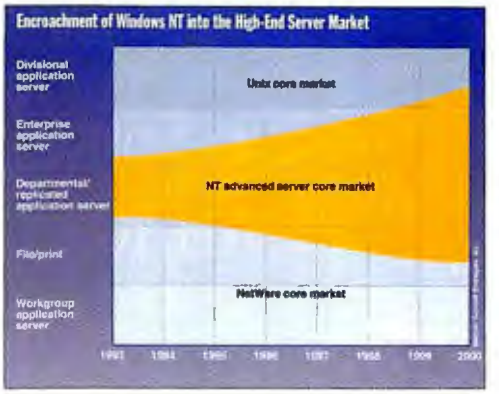
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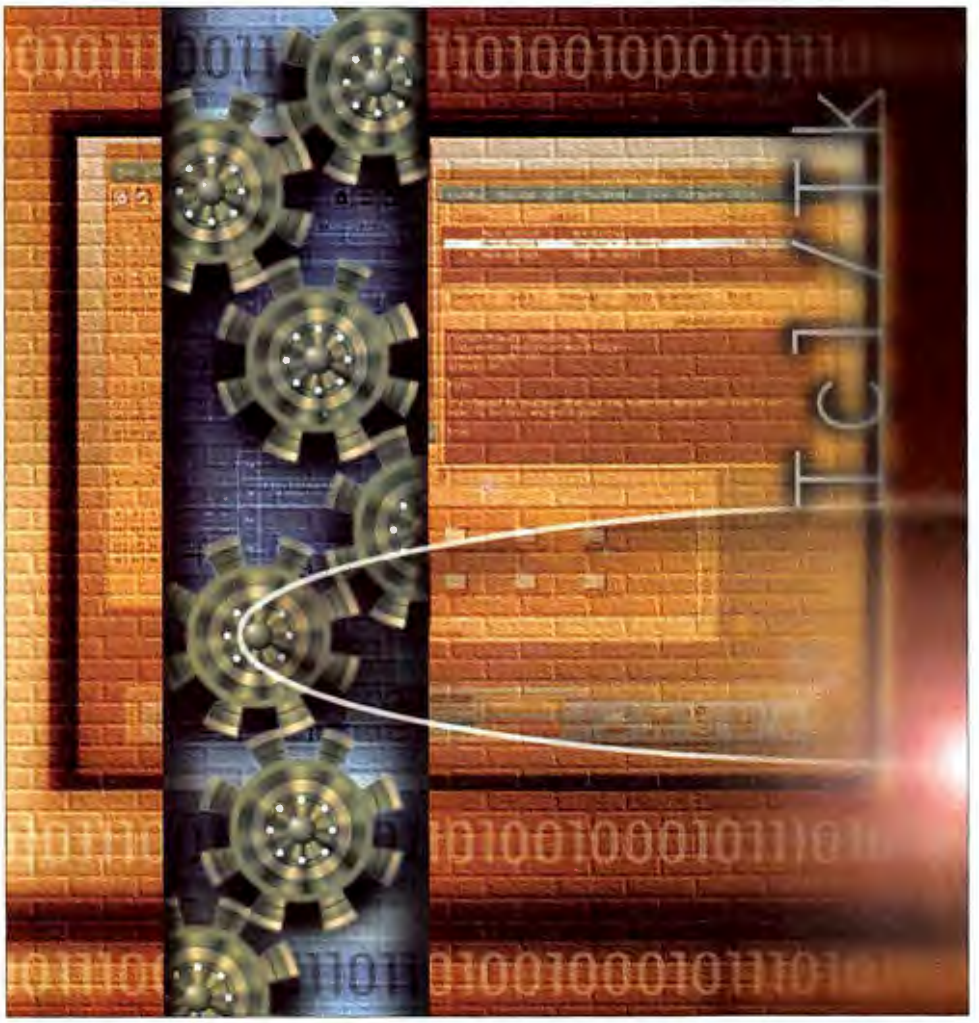


A Universal Desktop for Unix

The Common Desktop Environment grew out of fear of Windows NT's encroachment into the workstation enterprise market.

page 200DM 3

Unix Edition



Tickle Makes Developer Smile

Tcl provides a combination of extensibility, portability, easy embedding in C code, and simplified implementation of TCP/IP client/server communications that is hard for a developer to resist.

page 200DM 11

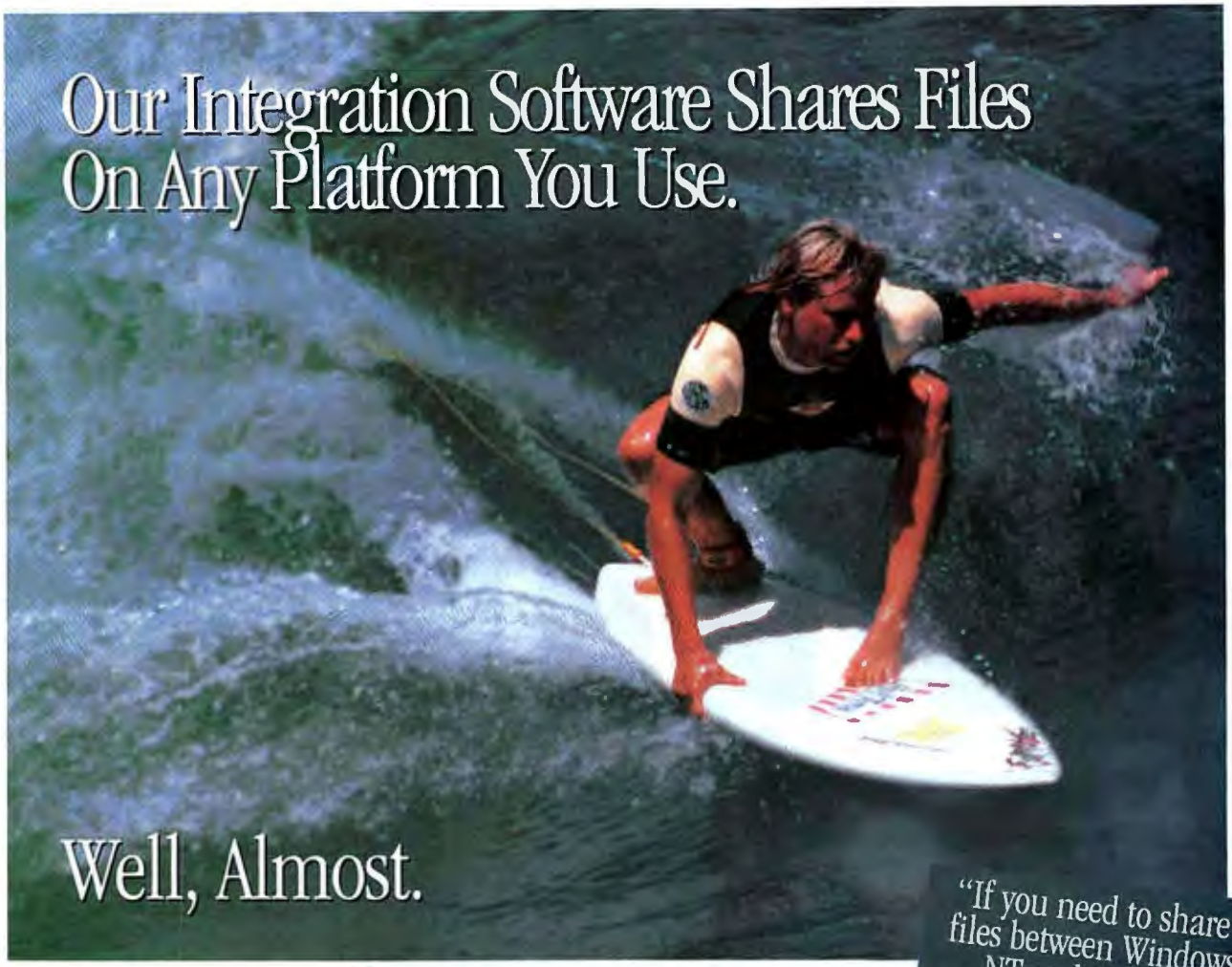
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A Universal Desktop for Unix

DOUG TAMASANIS



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The CDE (Common Desktop Environment) for Unix is here. The question is, who cares? Hewlett-Packard, Sun, IBM, and Novell care. They have invested two years and tens of millions of dollars in the development of CDE in the hope that the corporate world cares, too, and will buy into it. But is it too little too late?

The overall goal of CDE is to deliver a desktop interface to end users, software developers, and system administrators who want a common graphical user environment across multiple vendor platforms. According to John Sontag, chief architect of HP-UX for Hewlett-Packard, "CDE development was driven by user and developer demand." For end users, CDE presents an easy-to-use, intuitive environment offering the power of the Unix OS while hiding its complexities. For software developers, common services (such as the on-line help system) and a consistent set of industry-standard APIs across multiple hardware and software platforms make it easier to port to different flavors of Unix. For information systems professionals and administrators, CDE reduces the overhead of system administration in a heterogeneous environment.

CDE represents the first viable attempt by major Unix workstation vendors to provide a cross-platform windowing environment

CDE represents the first viable attempt by major Unix workstation manufacturers to provide a cross-platform windowing environment. The idea that CDE can gain Unix a significant foothold in a desktop market dominated by Apple and Microsoft is unrealistic. What it can do is prevent Windows NT from eating into the enterprise market currently dominated by Unix.

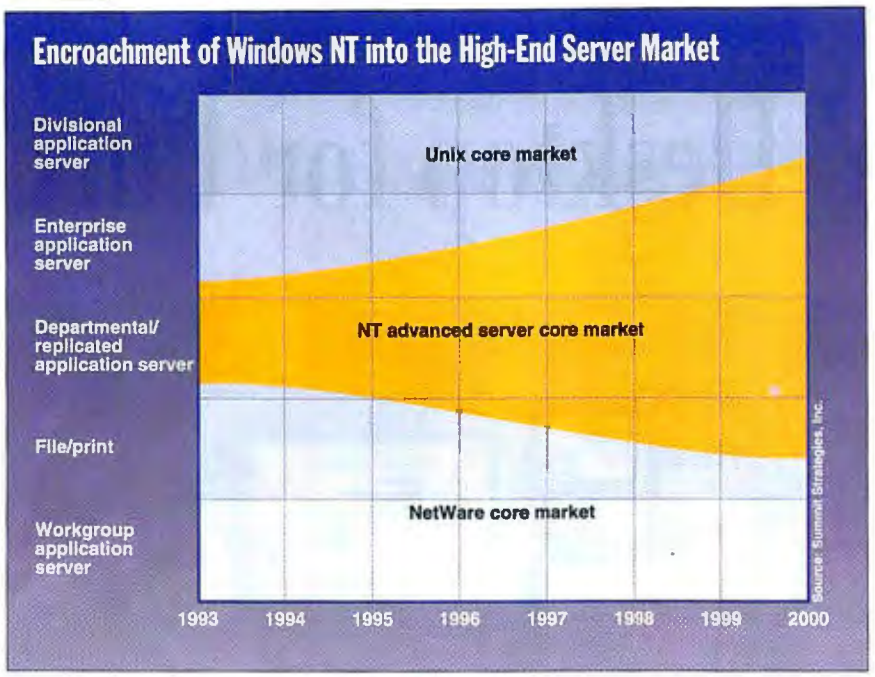
Why CDE?

What motivated this group of companies to join forces on a project requiring such enormous expense and engineering time? Most likely, they were driven together out of fear—fear of software giant Microsoft's future encroachment into the workstation enterprise market with the forever-promised, fully functional Windows NT.

The enterprise computing market (henceforth referred to as *workstation*) is one of the fastest growing portions of both the hardware and the software markets. Mainframe hardware and software sales are migrating to this market at an ever-accelerating rate. And there's more business here than you may think: Last year, IBM's mainframe software sales alone were roughly twice the gross sales of Microsoft. With such lucrative market potential, it is well worth the effort of Microsoft to try to capture a portion of this market, and it has already established a beachhead with NT.

Microsoft has proven it can turn hardware into a commodity and pull profit margins into software sales. In the past, workstation hardware vendors protected high profit margins with

Feature



Unix vendors currently control the high-end server market, and Novell is well positioned at the workgroup level. NT will enter the market at the departmental level, branching out toward the enterprise and divisional levels.

high-performance CPUs, proprietary Unix environments, and associated software. The threat of a PC workstation running a common enterprise OS like Windows NT could shatter the workstation market—a market already fragmented by a myriad of Unix flavors and hardware platforms.

According to a recent Summit Strategies report, Unix vendors have a three-year window in which to establish a defensive position in the high-end server market. (See the figure "Encroachment of Windows NT into the High-End Server Market.") Some think that Unix OSes are better for application development because NT doesn't yet provide the full capabilities of Unix. As Britt Johnston, database development manager at Progress Software, sees it, "A year or two from now, people may have NT on their system as their principal operating system, but for now, it is still Unix."

Unix currently controls the mission-critical enterprise market. Unix is a true multitasking and multiuser OS, with over 25 years of history. Many organizations base mission-critical business processes on Unix applications. System administrators are wary of turning these processes over to software that has not yet matured. Says Oran Thomas, chief developer of CDE at TriTeal, "Today Unix is the only viable operating system choice for mission-critical applications in the client/server marketplace. Although Windows NT has potential and may indeed be the future, it still needs to prove itself."

The problem with Unix is that the technical world was the driving force behind its evolution, resulting in shortcomings in the delivery of a common, easy-to-use interface. So as Windows NT takes aim at the most vulnerable aspect of Unix, workstation vendors finally teamed up to deliver a common desktop that works on all their platforms.

In March 1993, HP, Sun, IBM, and Novell announced the signing of a JDA (joint development agreement) to create a sample implementation of a CDE. They united existing technologies from participating vendors into a homogeneous desktop. The result is an application layer that contains a consistent set of APIs. CDE incorporates the workspace manager and user interface of HP's VUE (Visual User Environment) with features from IBM's CUA (Common User Access) model, Sun's desktop productivity tools (mailer and calendar manager), and Novell's UnixWare Client components. The desktop bundles together the X11R5 server and windowing system, the OSF Motif widget set and window manager, and Sun's ToolTalk interapplication communication layer.

The JDA called for CDE to consist of 80 percent existing technology and 20 percent new development and integration. An example of existing technology incorporated into CDE is the user interface, the bulk of which came directly from HP-VUE, a product that has been shipping on workstations for over five years. An example of the development of new technology for CDE is the integration of the various application components using the ToolTalk messaging system. Also, Sun's OpenLook MailTool and Calendar Manager required redevelopment under Motif. By using existing technology, the JDA members targeted delivery of CDE at one year from the JDA. Now, two years later, the release of CDE is a reality.

CDE: What It Is

Like its parent HP-VUE and most other Unix desktop environments, CDE is large, with over 2 million lines of code consuming 100 MB of disk space. It looks and feels much like HP-VUE, providing desktop management, session management, file management, application management, productivity tools, and application development tools. CDE also makes extensive provisions for integrating applications into the desktop.

CDE's extended Motif window manager includes a toolbar and virtual workspaces (see the screen shot). The toolbar, or front panel, holds icons for commonly accessed functions or applications, such as the mailer, file manager, printer, and trash can. The front panel has slide-up menus (the equivalent of pull-down menus but in an upward direction), allowing quick access to application launch icons. The front panel is completely configurable by the user or system administrator. The icons in the front panel fully support drag-and-drop operations.

A configurable number of virtual workspaces lets you organize work on separate screens. Configurable workspaces eliminate the need to search the desktop for open applications when you are working in a multiwindowed environment. At the click of a button, you can switch between workspaces and resume all applications with window sizes and locations in the same position as when you left the workspace.

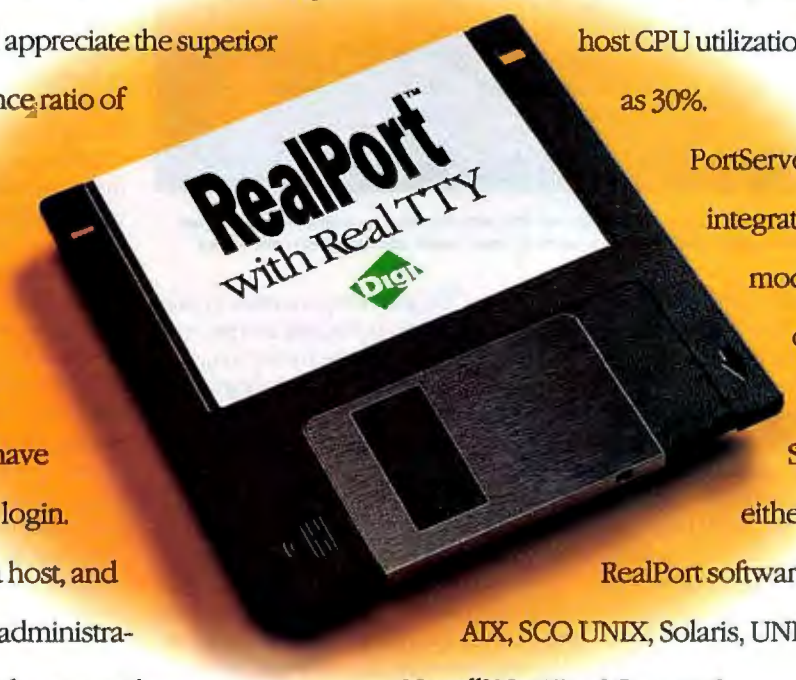
From the CDE desktop, you can record the state of your session and resume that session at a later time. CDE stores information about each running application when you log out, including the applications contained in each workspace, their size and position on the screen, and whether they have been iconified. The system uses this information when you log in again, restoring the session to its previous state. CDE also supports a home session, letting you return to the same initial state each time you log in.

From the applications manager, you can group applications into toolboxes. These toolboxes form hierarchical groups of related applications much like program groups in Microsoft Windows. A system administrator can set up these groupings

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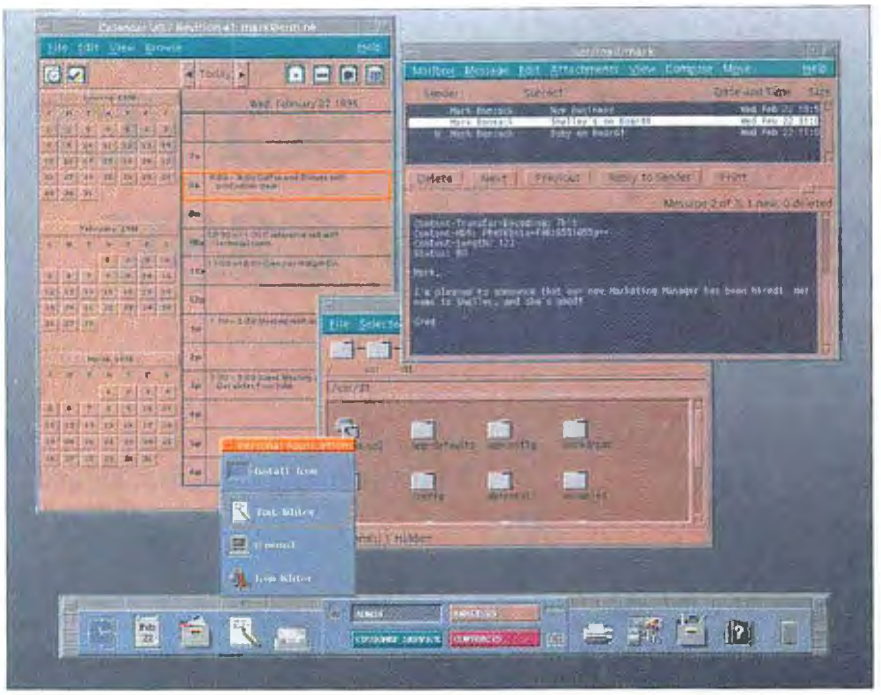
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Feature



The CDE (Common Desktop Environment) looks and feels like HP-VUE, with its toolbar, pop-up menus, and virtual workspace manager. The Motif version of Sun's desktop productivity tools (mailer and calendar) is also shown.

for all users, but you can configure additional custom applications as well. CDE features several default toolboxes, including Desktop Tools for easy access to CDE clients, X Window System applications, and other Unix system functions. Third-party applications can create additional toolboxes upon installation.

The file manager uses colorful icons to help users distinguish between data files, source code files, executables, images, and documents. You can move frequently used files, such as third-party applications, from the file manager directly onto the desktop, where you can easily access them.

A powerful feature of the CDE lies in its comprehensive Data Typing and Action Database functions. Data Typing refers to the ability to identify a file as belonging to a class. The Action Database provides a means whereby specific actions apply to a known data type. The method of identifying a file can be as simple as using a file extension (e.g., .doc or .txt for a text file, or .c or .h for a source file), examining the first few lines of data in the file for a certain substring of characters, or running an OS command (such as the Unix `file` command). From the file manager, icon style identifies file association. Double-clicking on an envelope icon always launches the mail program with the specified file loaded regardless of the file type or exension. Data Typing and the Action Database are fully configurable, so you can customize your desktop for specific work activities. CDE provides a number of predefined data types to simplify this process. You can select from preexisting icons, or you can create new icons with the provided icon editor.

Talking Tools

CDE bundles rich communications tools. The MailTool lets you compose, view, and manage E-mail through a GUI. It supports file attachments and communications with other clients through the optional ToolTalk messaging system. With the Calendar Manager, you can schedule and view appointments, create calendars, and send appointments to others via the MailTool using drag-and-drop.

ToolTalk provides a high-level communications mechanism by which the different CDE applications can pass complex messages. Upon initialization, each application that will participate in a session must register with ToolTalk. During registration, the application indicates what type of messages it needs to receive. When another application sends a message, perhaps about a file to be deleted, ToolTalk notifies all applications that have registered interest in file deletions.

Any client developer can make public a ToolTalk message that the client sends or receives. In this way, other clients may tightly interact with it. The clients defined by CDE (i.e., MailTool, calendar manager, and so forth) provide an initial set of public messages. Today, there is no defined repository for public CDE ToolTalk messages from ISVs (independent software vendors).

Application Development and Integration

CDE includes the tools needed by application developers to create CDE-compliant applications. This bundle includes the X, Motif, Help, Printing, and ToolTalk APIs. With CDE's application builder, developers can construct their application's user interfaces interactively. The developer manipulates Motif and CDE widgets graphically to create the interface and then later fills in the application's functionality using the X toolkit's callback mechanism. This application builder is particularly useful for user interface prototyping but may be inadequate for full implementations of complex applications.

In addition, a windowing version of the Korn shell, `dtksh`, provides a mechanism for creating Unix shell scripts with GUIs. This lets you quickly write simple, easy-to-maintain shell scripts with sophisticated user interfaces. `dtksh` is simply the Korn shell with built-ins for all the X toolkit, Motif, and CDE functions.

The CDE is a collection of different applications that work together on a unified interface. For example, pushing a button on the front panel of the desktop may activate a text editor so you can produce a document that you later drag from the file manager onto the printer icon or perhaps mail to another user. Although this simple example uses four different applications and two types of data exchange, to you it is a simple and intuitive sequence of actions. CDE provides developers and administrators varying levels of application integration within the desktop, depending on the overall goal of the integration.

The first level of integration requires only that an application be installed under the Application Manager folder on the desktop. This allows launching of the application by double-clicking on the application's action or data file icons. For most applications, this level of CDE integration will not require code modifications—only slight modification of installation scripts and the creation of some new files.

The second level of integration encompasses the first-level integration but also requires that the application comply with the OSF/Motif 1.2 Style Guide and the CDE Certification Checklist, a document listing the requirements for CDE application-level certification. Second-level integration includes the option to support non-English environments with the use of an internationalization programming guide.

The highest level of integration includes

the first two levels and additionally requires integration with the CDE desktop services, such as printing, drag-and-drop, and on-line help. Fully integrated applications provide the transparent manipulation and access to applications expected in a desktop environment. Application integration at this level is complex, requiring you to learn a new API for every service your application needs. Even the drag-and-drop function taken from OSF/Motif has a new API. Typically, the simpler things get for users, the more complicated they get for developers.

Where to Find
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Carlsbad, CA
(800) 755-8325
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Put Up or Shut Up

The marketplace will now get its chance to judge CDE on its promise to deliver the functionality and conformity of a universal Unix desktop. By the end of 1995, CDE will be available on SunOS 4.1.x, Sun Solaris 2.x, HP-UX 9.x and 10.x, IBM AIX 3.2.5 and 4.1.x, SGI IRIX 5.x, AT&T, SNI, and DEC OSF platforms, and Tektronix, Unisys, HP, and NCD X terminals. According to Hewlett-Packard's John Sontag, "Over the next 12 to 18 months, you will see the emergence of CDE platforms, while in 1996 and 1997, you will see the release of native CDE applications. Developers will not produce versions specifically for CDE but will wait for their next development cycle."

As with any new product, deficiencies exist in CDE 1.0. Some of these will be quickly evident, including limited support of standard formats in the help manager, meager functionality provided by the text editor, and lack of initial ISV integration and support. In addition, significant functionality remains undefined by CDE 1.0: fax, Internet access, device management, system administration, videoconferencing, PC interoperability, and desktop client security. Individual Unix workstation vendors will provide much of this functionality in a proprietary manner, while motivated ISVs will deliver a more homogeneous solution. At the very least, unless there is some horrific problem in the shipping version of CDE, it will achieve its purpose to unify the Unix desktop.

Now that CDE is a reality, the debate shifts to whether or not CDE delivers a truly common desktop across Unix platforms and whether or not the desktop functionality and APIs provided by CDE are superior to those of Windows NT. The core technology provided by CDE will stay substantially generic across the various vendors' CDE implementations. Vendors will make minor modifications to support specific customer bases or proprietary software products.

After that, you can throw out the word *common*. All Unix workstation hardware vendors will be bundling and integrating differentiating technology into their desktops. A significant portion of this technology will be proprietary in nature. Vendors will do this to protect their percentage of the workstation enterprise market. CDE defines a relatively limited set of desktop applications, leaving significant areas in which vendors can add value and gain a competitive edge. Windows NT, on the other hand, will provide a significantly broader collection of desktop capabilities with a higher degree of integration.

By providing differentiating value added, the Unix workstation vendors may damage the validity of CDE as a unifying

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desktop. Sound confusing? It is. The Unix workstation vendors spend millions of dollars developing a uniform desktop and Unix API specification, only to undermine the entire process by differentiating and providing proprietary capability.

In reality, it makes perfect business sense. If there were no differentiating capabilities within the workstation market, the hardware would become a commodity, and the profit margins would disappear. Since none of the Unix workstation vendors have demonstrated an ability to become a software company, they must protect the margins in their hardware.

It appears that the goals of COSE and CDE were twofold. The first consideration was to project an image of ultimate uniformity and harmony throughout the Unix workstation community so as to remove any leverage Microsoft might have in the enterprise marketplace by claiming Unix to be fragmented and isolated. The second and maybe more overriding consideration was to find the minimal level of uniformity required to achieve this while leaving room for the differentiation needed to protect profit margins.

What the Enterprise Really Needs

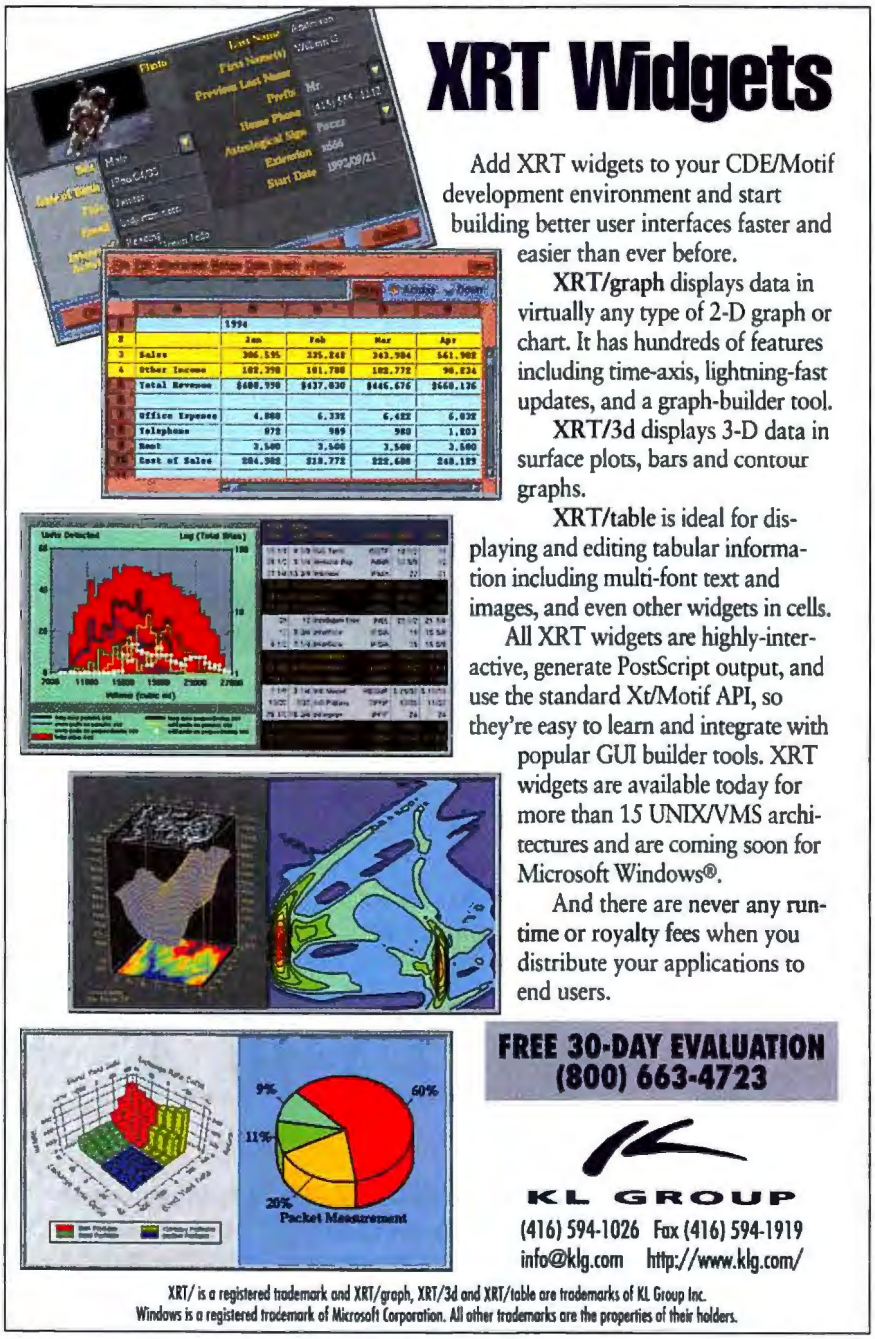
How will the true promise of CDE be realized by enterprise customers today? One avenue will be through software vendors whose main goal is to deliver a homogeneous CDE implementation across the heterogeneous Unix workstation marketplace. This implementation would stress commonality in function, configuration, and installation. Rather than OS and hardware release schedules and proprietary technology intended to protect hardware margins, enterprise customer needs would define its content.

One company working in this direction is TriTeal of Carlsbad, California, which claims that its TED (TriTeal Enterprise Desktop) will deliver a universal, generic version of CDE throughout the Unix enterprise. TED even comes with bundled technology that adds value to basic CDE. This includes clients such as fax, videoconferencing, Internet access, and PC interoperability—all of which will be common across platforms. With TED, TriTeal has tried to produce a true common desktop environment—networked, multiuser, multitasking, and interoperable—that still leaves room for the enterprise software.

It is unfortunate that the workstation vendors couldn't have agreed on CDE years ago when there was still a possibility that Unix could become a significant presence on the desktop. There is a possibility for limited success if enough application developers integrate their applications into CDE. There are rewards for developers who port to CDE, namely, fully integrated applications and uniform service applications on all supported platforms. The latter will let developers use fewer lines of code to extend applications. "CDE is a huge win for smaller workstation vendors who can look like the bigger companies without incurring the high cost of GUI development," says Britt Johnston of Progress Software.

The real winners could be the users, who would have a single desktop environment and consistent application interfaces across workstation platforms. The idea is valid; unfortunately, the product may be too late.

Doug Tamasanis is a BYTE senior technical editor with B.S. and M.S. degrees in radiation physics and an M.S. degree in systems engineering. You can reach him on the Internet at dtam@bix.com or on BIX as "dtam."



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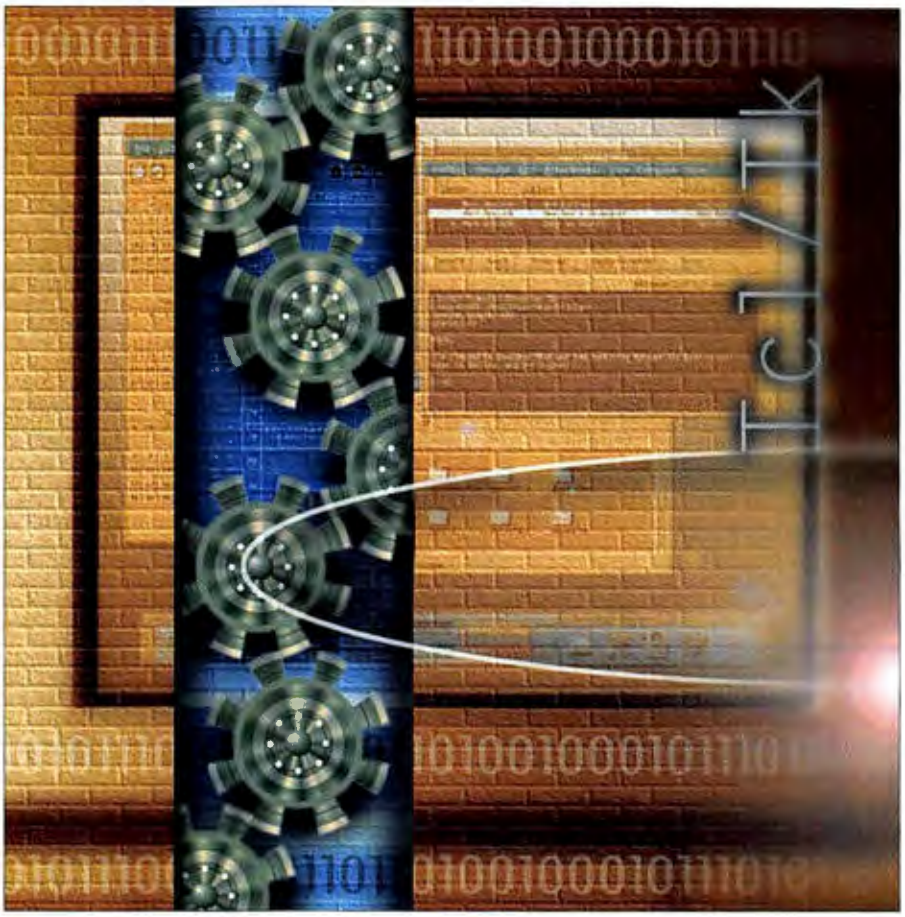
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Buy It And Save.

Tickle Makes Developers Smile

TERRY R. COLEY



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As a scripting language, the Tool Command Language (Tcl, pronounced "tickle") has hit a sweet spot in the applications programming community. Tcl and its common extensions offer a combination of features—extensibility, easy embedding in C code, and simplified implementation of TCP/IP client/server communications—that developers find hard to resist. At the script level, Tcl's benefits extend to application users as well. Well-designed application-specific Tcl commands give users a flexible control language.

An excellent example of a Tcl extension is the popular Tk X Window System interface, which supplies a broad set of easy-to-manipulate script-driven graphical widgets. With Tk and Tcl's TCP/IP extensions, it's easy to write applications that take advantage of client/server architecture. Tcl-driven programs also provide the opportunity to create useful collections of scripts that implement common, higher levels of functionality not considered by the original programmer. Perhaps best of all, Tcl is free for downloading (see the text box "Availability of Tcl and Tk" on page 200DM 18), and you can distribute your Tcl-based applications royalty free.

With Tk and Tcl's TCP/IP extensions, it's easy to write applications that take advantage of client/server architecture

A Taste of Tcl

Tcl is a simple programming—or, more aptly, scripting—language. Like any true programming language, Tcl supports variables and control structures.

Everything is a string in a Tcl script. More precisely, the parser treats arguments to commands as strings, and it's up to individual commands to interpret these strings. For example, the `set` command takes two arguments: a variable name and a value. (See the listing "Loop.") The `if` command also takes two arguments—a conditional expression and a body—to optionally execute. To the Tcl parser, the two strings enclosed in braces—`{$a == "hello"}` and `{puts "a passed the test"}`—are simply strings. It is up to the underlying code implementing the `if` command to make sense of the strings.

The everything-is-a-string characteristic lets you pass snippets of Tcl code around via variables. The variable `command` in "Loop" contains the entire `for` loop, making it possible to manipulate it or pass it to another part of the Tcl script just like any other variable. In fact, you can use variables to build up sequences of executable Tcl commands.

"Loop" executes the stored `for` command immediately by passing it to the Tcl `eval` command. The `eval` command takes a single argument and passes it recursively to the Tcl interpreter.

So the Tcl syntax is simple. New lines or semicolons separate sequences of commands and their arguments. Also, new lines contained within braces represent a single string, allowing control commands to easily execute arbitrarily long blocks of Tcl code.

continued

Feature

Tcl Features

A scripting language is ideal for orchestrating a sequence of events. Unix shell scripts, and even DOS batch files, are examples of scripts that automate a sequence of events.

Scripting languages, including Tcl, are typically interpreted and not compiled. Tcl has two additional characteristics that are responsible in large part for its incredible success as a multipurpose scripting language: embedability and extensibility.

You can easily embed the power of the Tcl interpreter in your C/C++ applications because the interpreter is implemented as a C library. A single call to `Tcl_CreateInterp()` creates an instance of a Tcl interpreter object. To use the interpreter, your application passes strings into the `Tcl_Eval()` function. For example, the `tclsh` program in the Tcl distribution simply collects strings from the command line or input file and passes them to a Tcl interpreter.

After you've embedded the Tcl interpreter in your application, you will want to extend it to implement functions specific to your application. The `Tcl_Create` command function attaches a new Tcl command, which you specify to compiled code and binary data that you implement. From then on, any time the Tcl interpreter encounters your command, all the arguments will be parsed and sent as C character pointers to your C function.

Because the application-specific commands become part of the Tcl language, all the work to create a truly powerful scripting language for the application has been done. Each time you write a new application using the Tcl interpreter, that application gets variables, program control commands, and file I/O commands; indeed, it gets the whole Tcl language with no effort. Once you learn to write scripts for one Tcl-based application, you are well on your way to being effective with any other Tcl-based application.

Loop

```
set a hello  #sets variable a to hello
set b $a     #sets variable b to hello
if {$a == "hello"} {puts "a passed the test"}
set command {
  for {set i 0} {$i < 4} {incr i} {puts "i = $i"}
  }
eval $command
```

The Tk Toolkit

Possibly the most widely used extension to Tcl is the Tk Toolkit, concurrently developed by Dr. John Ousterhout (Sun Microsystems) along with Tcl. The Tk Toolkit implements a broad set of graphical widgets that display on X servers. The key difference between Tk and other X widget sets is that you can create and manipulate each widget using Tcl commands. A program called `wish` reads interactive input or lines from a script and passes them to an extended Tcl interpreter that implements the Tk Toolkit widget set. Using Tk, you can create X applications using simple, interpreted scripts. The scripts do not require compiling or linking, simply a text editor and the `wish` program.

To get a sense of the advantages of Tk scripting, compare a simple "hello world" application implemented in Motif with one implemented in Tcl/Tk. The application displays a window with a text message and waits for the user to click a button to terminate the application. The listing "Motif Hello World" contains the Motif script, and the listing "Tcl/Tk Hello World" contains the Tcl/Tk script.

Tcl/Tk Hello World

```
#!/usr/local/bin/wish -f
button .hello -text "Hello, world" -command exit
pack .hello
```

The first line in "Tcl/Tk Hello World" initiates the interpreter (`wish`) that will run the Tcl/Tk script. The second line creates a button widget, specifies its name (.hello), its text (Hello, world), and the callback `command` executed when you press the button (`exit`). The final line places the button widget (.hello) in the top-level window managed by the `wish` program.

Tcl/Tk and the `wish` interpreter provide a tremendous simplification for building X applications, opening the world of creating X applications to a much broader audience. However, even if you are comfortable with Motif and C/C++ programming, you should consider some of the other advantages to coding with Tcl/Tk. (See the table "Tcl/Tk Features Summary" on page 200DM 14 for a summary of the pros and cons.)

The normal development loop consists of editing source code, compiling and linking, and testing and debugging. You repeat this process until the script functions correctly. The compile-link phase can become a significant time investment, especially with large X applications. Because of the interpreted nature of Tcl/Tk-based applications, you bypass the compile and link phases.

For larger Tcl/Tk applications, pieces of the application can reside in totally separate script files. In these cases, it is even possible to debug a new component while

Motif Hello World

```
#include <stdio.h>
#include <X11/Intrinsic.h>
#include <Xm/Xm.h>
#include <Xm/PushB.h>

void Quit(w, client_data, call_data)
Widget w;
XtPointer client_data, call_data;
{
 fprintf(stderr, "It was nice knowing you.\n");
 exit(0);
}
main(argc, argv)
int argc;
char **argv;
{ XtAppContext app_context;
  Widget topLevel, goodbye;

  topLevel = XtVaAppInitialize(
   &app_context,
   "Xgoodbye",
   NULL, 0,
   &argc, argv,
   NULL,
   NULL);

  goodbye = XtVaCreateManagedWidget(
   "goodbye
   xmPushButtonWidgetClass,
   topLevel,
   NULL);
  XtAddCallback(goodbye, XmNactivateCallback, Quit, 0);
  XtRealizeWidget(topLevel);
  XtAppMainLoop(app_context);
}
```



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Feature

TCL/TK FEATURES SUMMARY

Advantages	Disadvantages
• Reusable in multiple applications	• Slow execution speed
• Simple syntax	• Poor for data-intensive applications
• Storage of command sequences in variables	• New compilers eliminate portability
• Embedability	• Lack of debugging tools
• Extensibility	• Difficult to develop large applications
• The Tk Toolkit	
• No compiling or linking	
• Runs on any `wish`-equipped machine	
• Compilers available soon	
• Easy client/server implementations	



the main portion of the application is running. For example, suppose you are changing or debugging a new dialog box. The main application invokes the Tcl procedure responsible for displaying the dialog box and returning a result to the main script. After testing the dialog box, you find that it returns an incorrect value or does not look the way you want it to. You edit the script containing the dialog box code. Now the main Tcl/Tk script must simply `source` the new script file and reinvoke the dialog box using the new code.

Tcl/Tk Windows applications run on any machine with an executable version of the `wish` interpreter. Chances are you won't have to do any additional work to port your application across Unix platforms (and now even Microsoft Windows), because `wish` has been ported to almost every Unix platform. This is a distinct advantage to software developers looking to support a wide variety of platforms.

Some Disadvantages

Creating X applications using Tcl/Tk has a few disadvantages when compared with development in C/C++. Due to their interpretive nature, Tcl/Tk scripts are slower than compiled X applications. However, depending on the application, the speed difference may not be discernible. In fact, unless you are doing large amounts of string manipulation, you will find that Tcl/Tk-based applications and user interfaces perform as well as compiled code.

Where performance has remained an issue, some developers have augmented the Tk widget set using new C/C++ code. The result is a new `wish` interpreter that understands the command for an application-specific widget. This solves the performance issue at the price of losing the automatic platform portability.

Finally, excellent debuggers exist for working with C/C++ code. Such tools do not yet exist for Tcl-based code. For this reason, you should be cautious about developing overly large applications in Tcl/Tk.

Despite its disadvantages, Tcl/Tk is a powerful tool for rapid application and user interface development. Developers and users alike use Tcl/Tk to create functional Unix applications. One specific area in which Tcl/Tk scripts are particularly useful is in Unix system administration.

System Administration with Tcl

Unix system administration is a broad topic involving many areas, such as network administration, user account administration, security, policy enforcement, and process monitoring. The application described here is a Tcl-based toolkit called KIS (kernal information system), developed for monitoring process information

```
1.  #!/usr/local/bin/kisd -f
2.
3.  set l [kis list -create PPID STATUS USER COMMAND]
4.  set allProcesses [kis scan $l]
5.  set f [kis filter -create $l {STATUS == "defunct"}]
6.  set defunctProcesses [kis filter $allProcesses $f]
7.  set defunctList [kis format $defunctProcesses]
8.
9.  puts "The following processes are defunct:"
10. set header [kis format -header $defunctProcesses]
11. # strip TIMESTAMP from header
12. set header [lrange $header 0 [expr [llength $header]-2]]
13. puts $header
14.
15. foreach process $defunctList {
16.   set pid [lindex $process 0]
17.   puts $process
18.   set ppid [lindex $process 1]
19.   while {$ppid != 1} {
20.     set f2 [eval "kis filter -create $l {PID==$ppid}"]
21.     set parentProcess [kis filter $allProcesses $f2]
22.     set parent [kis format $parentProcess]
23.     kis filter -delete $f2
24.
25.     if {[llength $parent] > 0} {
26.       set parentInfo [lindex $parent 0]
27.       set ppid [lindex $parentInfo 1]
28.       puts " -->$parentInfo"
29.     } else {
30.       set ppid 1
31.     }
32.   }
33. }
```

Finding Defunct Processes

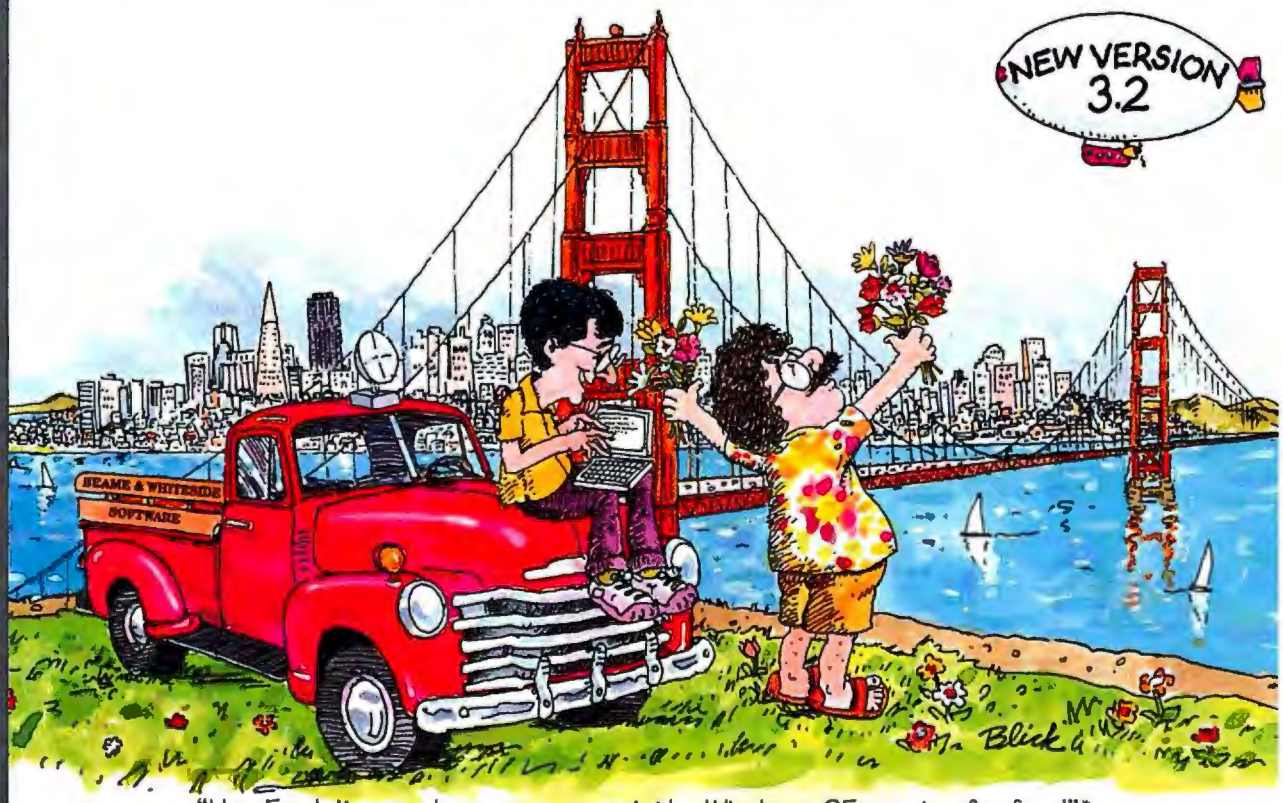
Here, line 3 defines the KIS list of items to extract (PID is implicitly always the first item of the list). The search for defunct processes is done at the expense of a single kernel scan done in line 4. In line 6, the script performs a filtering operation of the kernel snapshot (stored in a KIS scan referred to by Tcl variable `allProcesses`) to create a secondary KIS scan containing only the defunct processes. Every KIS scan of the kernel has an associated header with two pieces of information: a time stamp showing the collection time of the information and an ordered list of the attributes collected for each process. Lines 10–13 serve to ignore the time stamp information and output a simple header.

Line 15 begins a loop over each defunct process. The body of the loop first outputs information on the process. The loop in line 19 begins a traversal of the process's parentage, terminating at `PID` == 1. The initial condition for the loop (line 18) stores the parent of the defunct process in `ppid`. The script constructs a temporary filter for each iteration (line 20) that locates the process for which `PID` == `$ppid` in the original, complete KIS scan. Parent information is output at line 28. The parent list will always contain one element (which is itself a list of PID PPID STATUS USER COMMAND for the parent) unless the parent died during the original kernel scan. The `if` statement in line 25 handles this contingency and will terminate the loop if a parent is not found (line 30).



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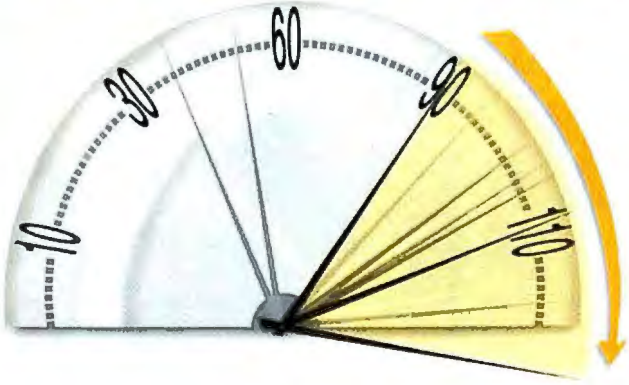
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on networks of Unix computers.

Suppose you are the system administrator for a multivendor network of computers used as compute servers. The servers are used to run extended simulations or to perform CPU-intensive database operations. A defined policy exists regarding how many CPU resources each individual user and each group collectively may use. Your job is to monitor and enforce that policy.

To accomplish this, you will need tools for managing Unix processes. You have several options to accomplish this job. You might try writing your own Unix shell scripts, writing your own C programs, or using commercial system management software. Each route has its own disadvantages: Process information may not be available from the Unix shell on various platforms; a C language approach is complicated and vendor specific; and many commercial systems are large and expensive and do more than you need. The combination of Tcl/Tk and KIS may provide the customizable solution you need.

Much like programming X applications, Unix kernel programming is a complex task further complicated by differences among the many Unix vendors. Taking advantage of the capabilities of Tcl/Tk, KIS solves this problem by making Unix kernel data on multiple Unix platforms available to Tcl scripts. Two listings of Tcl/Tk scripts demonstrate how easily you can develop kernel-level system monitoring with KIS. The first deals with finding defunct processes, and the second determines the number of processes per user.

Case 1: Finding Defunct Processes

Defunct processes are processes that have terminated but the parent process has not yet executed the Unix `wait()` or related system call for that child. This is usually an abnormal condition. Too many defunct processes can clutter the kernel, needlessly consuming process slots. It is useful to be able to identify defunct processes and look at their parentage quickly. When appropriate, issuing a kill on the parent will often free the process slots of the defunct process as well as the parent.

The KIS script "Finding Defunct Processes" displays the process ID, parent process ID, current state, ownership, and command string used to execute each defunct process. Additionally, the script displays the defunct process's parent tree up to `PID == 1` (the `init` process). Using this information, system administrators can kill selected parent processes. This script can also function as the starting point for creating a script to automatically clean the system on a regular basis.

continued

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Feature

Case 2: Processes Per User

"Finding Processes Per User" uses the Tcl/Tk/KIS tools to determine how many processes belong to each user or a particular user on a specific host. This 45-line script lets a system administrator specify a host and also a particular user, if desired. For example, if you would like to know how many processes belong to user1 on host2, you could type `nproc -u user1 -m host2`.

In the script, lines 2–25 process the command-line arguments, while lines 27–45 perform all the work. Two important new ideas appear in this script: a KIS sort filter and the `tcp` command for network communication. The `tcp` command establishes a connection to a KIS daemon that acts as a proxy to collect the desired information on the remote host. From your point of view, the only new wrinkle is that you must prefix all KIS commands

Availability of Tcl and Tk

Although Tcl grew up in a Unix environment, three different Microsoft Windows ports are available, one at `ftp://ftp.ms.uky.edu/pub/tk-win` and another from a group in Japan at `ftp://ftp.sra.co.jp/pub/lang/tcl` (look for files named `tkwine*`). The third port, for Windows NT, is available at `ftp://mm-ftp.cs.berkeley.edu/pub/multimedia/winnt/tknt36r3`.

Tcl/Tk on the Internet
You can download the Tcl/Tk distribution from `ftp://ftp.cs.berkeley.edu/ucb/tcl`

The Extended Tcl interpreter features many more Unix system-level access commands. It is available at `ftp://ftp.aud.alcatel.com/tcl`

FAQ (Frequently Asked Questions)
`http://www.cis.ohio-state.edu/hypertext/faq/usenet/tcl-faq/top.html`

John Ousterhout's Home Page
`http://playground.Sun.COM:80/~ouster`

Wade Holst URL
A particularly useful collection of Tcl/Tk starting points is available at `http://web.cs.ualberta.ca/~wade/Auto/Tcl.html`

On-line Manual Pages (Tcl language and C language API)
`http://www.sco.com/IXI/of_interest/tcl/tcl_man.html`
`http://www.sco.com/IXI/of_interest/tcl/tk_man.html`
`http://www.sco.com/IXI/of_interest/tcl/tclAPI_man.html`
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Tcl and the Tk Toolkit Book
John Ousterhout's book, *Tcl and the Tk Toolkit* (Addison-Wesley, 1994, ISBN 0-201-63337-X), is available at many bookstores. You can also request a copy by sending E-mail to info@pgrams.com.

Unix System Management
The listings in this article are available on-line, at `ftp://wag.caltech.edu/pub/kis`



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Feature

```
1.  #!/usr/local/bin/ptclsh -f
2.  set oneUser 0
3.  set host localhost
4.
5.  for {set i 0} {$i < $argc} {incr i} {
6.      set arg [lindex $argv $i]
7.      case $arg {
8.      -m {
9.      incr i
10.     set host [lindex $argv $i]
11.     }
12.     -u {
13.     incr i
14.     set userFilter "USER == \"[lindex $argv $i]\""
15.     set oneUser 1
16.     }
17.     default {
18.     puts "Usage: $argv0 -options"
19.     puts "Options:"
20.     puts "-m (machine - specify host)"
21.      puts "-u (user - specify one user)"
22.     exit 1
23.     }
24.     }
25. }
26.
27. set c [tcp connect $host [kisPort]]
28. set l [$c send kis list -create USER]
29. set sort [$c send kis filter -create -sort $l {USER}]
30. if $oneUser {
31.     set f [$c send kis filter -create $l $userFilter]
32.     set s [$c send kis scan $l $f $sort]
33. }
34. else { set s [$c send kis scan $l $sort] }
35.     set o [$c send kis format $s]
36.
37. set formStr "%15s %4d"
38. set totPID 0
39. foreach userData $o {
40.     set userNproc [llength $userData]
41.     incr totPID $userNproc
42.     set userName [lindex [lindex $userData 0] 1]
43.     puts [format $formStr $userName $userNproc]
44. }
45. if !$oneUser [puts [format $formStr "Total:" $totPID]]
```

Finding Processes Per User

Lines 2–25 process the command line. The `tcp` *on line 27 establishes a connection to a KIS daemon that acts as a proxy to collect the desired information on the remote host. All KIS commands are prefixed with* `$c send`*, indicating to send the command to be executed in the KIS proxy process on the remote host.*

Line 28 creates a KIS list, indicating that for each process you need only the USER (process ownership) attribute. Line 29 creates a KIS sort filter, resulting in the return of sorted information by USER. According to the command-line input, the script requests either all processes or only those processes belonging to a specified user.

Line 32 shows the simultaneous use of a KIS filter and a KIS sort filter to extract selected items and sort them. In this case, the sort by USER is trivial because the selection filter specifies one user. Each KIS sort filter adds an extra nesting level to the output of the `kis format` *command (line 35). The script employs the sort even in the one-user case so that the same loop structure (lines 39–44) handles the output list (*`$o`*). The extra nesting of the results groups processes with equal values of the sort filter. The* `foreach` *loop handles each unique value of USER and then simply counts the items in the subsidiary list.*

with `$c send` to indicate that the command is to be sent to and executed in the KIS proxy process on the remote host.

Suppose you are interested in learning only about particular processes belonging to a user—for example, processes that are demanding more than a threshold of CPU resources? One way to modify "Finding Processes Per User" to collect only the important processes would be to create an additional KIS filter. A filter like "`CPU > 60 && delta(CPU)/delta(TIMESTAMP) > 10%`)" will select only those processes with more than 60 CPU seconds and which occupied more than 10 percent of the CPU time between successive scans. The KIS `delta()` operator allows examination and filtering based on changes between successive KIS scan calls. To implement the above filter meaningfully requires an initial scan, followed by a pause, followed by another scan.

Tcl and Networking

The ability to communicate between Tcl-based applications running on the same or different hosts is one of the most powerful extensions added to basic Tcl. The extension uses TCP/IP connections to implement inter-application communication between Tcl-based clients and servers. Typical of Tcl-based codes, the `tcp` command boils down the complexities of TCP/IP sockets programming to a few useful Tcl options. The networking Tcl commands `tcp connect` and `$c send` give you all you need to develop useful client/server Tcl-based scripts.

The `tcp connect` command requires a host name and a port number to make a connection. (In the listing "Finding Processes Per User," the `kisPort` command supplies the locally configured port set up by the system administrator used for KIS proxy daemons.) When the script specifies the KIS port for a connection request, Unix (through `inetd`) takes care of starting up a KIS proxy daemon on the remote (or local) host. The proxy daemon becomes an information server, and the requesting application becomes the client.

After the code implementing the `tcp connect` command establishes a TCP/IP connection, it creates a new command in the Tcl interpreter of the client. The name of the new command is returned as the string result of the `tcp connect` command and is usually captured in a variable in the client application's interpreter.

The saved result of the `tcp connect` command is used by the client application for further reference to the newly created connection. Assuming you store the created connection command in the interpreter variable `c`, invoking this command with the `send` option (`$c send ...`) results in the remaining arguments on the command line being sent to the server as an executable command in the server's interpreter.

In "Finding Processes Per User," all the KIS commands were executed in the KIS proxy server via `$c send`. In fact, the client code does not need the `kis` command built into its interpreter at all, but it does need the `tcp` command.

Future of Tcl

Every once in a while, an innovation comes along that changes the way a large number of people build software. Tcl certainly falls into this category. The Tcl/Tk combination provides an amazingly productive way to create X applications. Best of all, Tcl/Tk and many extensions are distributed free with copyrights that allow unrestricted, royalty-free commercial use.

Just as Tk makes building X applications far more productive than using the X Windows C language interface, KIS lets system administrators build complicated, networked Unix process management applications with a fraction of the effort required to learn Unix kernel interface programming. ■

Terry R. Coley is the president of Parallelograms, where he focuses on managing software design. He holds a Ph.D. degree in computational chemistry. You can reach him on the Internet at pgrams@netcom.com. or on BIX c/o "editors."

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What's New

UNIX FOR THE MAC

Mach[ten] 4.0 ($695) brings Federal Information Processing Standard 151-2 Posix-compliant Unix to Macintosh and Power Macintosh platforms. The package provides preemptive multitasking and a full-featured high-performance TCP/IP protocol stack with Internet application protocols that support file transfer, virtual terminals, and E-mail. Also included are Internet tools (domain name service and Internet control message protocols), serial (compressed SLIP and PPP) and Unix (`rsh` and `rexec`) communication support, industry-standard client/server NFS file sharing, a full suite of Unix software development tools with C and C++, and a complete implementation of X11R5.

Contact: Tenon Intersystems, Santa Barbara, CA, (805) 963-6983.

Circle 1254 on Inquiry Card.

UNIXWARE 2.0

UnixWare 2.0 ($99) is a full-featured Unix OS for Intel x86-based platforms. Its highlights include SMP (symmetric multiprocessing) support that lets software take advantage of computers with multiple processors. Improved NetWare integration provides single log-on access to databases running on a Unix server through a NetWare LAN. Additional features include 32-bit processing with a fully multithreaded kernel and preemptive multitasking, asynchronous I/O, user-level threaded APIs, and dynamically loadable modules.

Contact: Novell, Summit, NJ, (408) 434-2300.

Circle 1255 on Inquiry Card.

UNIX-TO-PC CONNECTIVITY

This user environment for distributed computing systems provides transparent access to Unix facilities and applications from Unix and PC desktop systems. Eye2eye ($595) provides Motif 1.2 run-time libraries with Motif/CDE or Microsoft Windows 3.1 style, appearance, and behavior; interoperability with the Windows control panel; and automatic conversion of Motif and Windows clipboard formats.

Contact: IXI Corp., Santa Cruz, CA, (408) 429-4500.

Circle 1257 on Inquiry Card.

INCLUSIVE INTERNET SERVER

The Netra Internet server comes with a complete suite of software, including configuration utilities, security software, an E-mail gateway, and file-transfer capabilities. Netra provides direct desktop Internet connections for PC, Mac, and Unix workstation users on LANs. The server supports Mosaic as well as other network browsing tools. A base configuration includes 16 MB of RAM and 535 MB of hard disk storage ($6149), and an upper-level system provides 32 MB of RAM and a 1.05-GB hard drive ($8499) and can be expanded to four processors.

Contact: Sun Microsystems, Mountain View, CA, (800) 821-4643 or (214) 386-8415.

Circle 1258 on Inquiry Card.

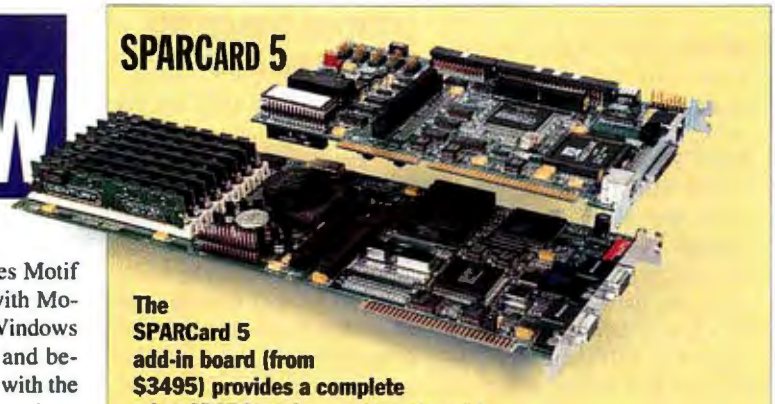
UNIX HSM

Metior HSM software provides distributed hierarchical storage management for Unix. Metior software can drive 12 tapes simultaneously in MediaLogic ADL's (Boulder, CO) SLA-8max (1.23-TB maximum storage) and SLA-4max (960-GB maximum storage) libraries or seven drives in the SLA-D (multiterabyte storage). The system is available on SunOS, Solaris, SGI, HP-IX, and SCO Unix platforms. There is also client support for NFS-mountable environments, including NetWare, OS/2, Macintosh, and VMS. An 8mm base unit with three drives and 28 cartridges ($17,595) provides storage of 392 GB of compressed data and 196 GB of uncompressed data.

Contact: Automated Network Technologies, Englewood, CO, (203) 235-0035.

Circle 1259 on Inquiry Card.

SPARCard 5



The SPARCard 5 add-in board (from $3495) provides a complete microSPARC environment designed to fit on a PC. Features include microSPARC II processor support, improved AT Bus throughput, expanded memory capability, and modular processor upgrade design. The three-board modular set fits into two ISA/EISA slots. Options include 70-, 85-, or 95-MHz processors; 500-MB or 1-GB hard drives; and up to 128 MB of RAM. All boards include standard Unix workstation I/O ports and the Solaris OS. Special software designed by Opus lets the PC monitor, mouse, keyboard, and floppy drive support both Unix and PC environments. A single keystroke or mouse-click switches between DOS and Unix environments and enables file transfers between environments.

Contact: Opus Systems, Santa Clara, CA, (408) 562-9340.

Circle 1256 on Inquiry Card.

VOICE/DATA/FAX CONCENTRATOR

A concentrator from MultiTech Systems can simultaneously handle voice, data, and fax. The single-channel MMV101 ($1299) bridges LAN, PBX, fax, and E-mail over a single telecommunications line. Communications lines can be analog, ISDN, Switched 56, fractions T1, or any DSU-based service operating at up to 128 Kbps. The MMV101 handles up to 128 Kbps synchronous or 115 Kbps asynchronous data transfer rates. The voice/fax interface can be to a PBX system, key system, or telephone using a standard FXO or FXS interface.

Contact: MultiTech Systems, Mounds View, CA, (908) 542-6121.

Circle 1261 on Inquiry Card.

SCHEDULING ON UNIX

Lucas has ported Artemis Scheduler Publisher 4.2 ($1995) to the Unix platform. Available in eight languages, it provides enterprise-wide project management and cross-platform functionality and can merge, link, or exchange data across Unix, Windows, and Macintosh platforms. In addition, Artemis Scheduler Publisher can break down projects into smaller portions and then link them up to a master plan. It lets managers determine the length of a task based on required effort and available resources, and perform updated data transfer with off-the-shelf project management systems or databases.

Contact: Lucas, Fairfax, VA, (703) 734-1052.

Circle 1260 on Inquiry Card.

MULTIPLE LAN ROUTERS

NetBlazer LS ISDN ($1399) and NI2B ($1660) routers are capable of simultaneouly routing TCP/IP and AppleTalk communications, as well as Ethernet, to LocalTalk traffic. The routers also support ARA 2.0, frame relay, and interface balancing. Both include seven levels of

security, consisting of ID/password, callback, DES-based cryptographic handshake, filtering, Kerberos, SecurID, and PAP/CHAP. Both also support SNMP MIB II and enterprise MIB. Special ISDN (and syncronous communication) features include 4-to-1 compression using the STAC algorithm, 5ESS, and DMS 100 switch support as well as adherence to ISDN 1 and B channel protocol PPP.

Contact: Telebit Corp., Chelmsford, MA, (508) 441-2181.

Circle 1262 on Inquiry Card.

FILE-SHADOWING SOFTWARE

An on-line backup system takes periodic snapshots of a SPARC workstation's file system, letting users retrieve previous versions of a file with a single mouse-click. ZShadow ($695 desktop, $1195 server) stores the watchpoint of a Unix file system in a special save area on a system's hard drive. Typically, a 100-MB disk partition is sufficient for the average system. Shadowing occurs in the background without any user intervention. Because snapshots record only incremental effects, saving typically takes just a few seconds.

Contact: Zzyzx, San Diego, CA, (619) 292-7400.

Circle 1263 on Inquiry Card.

DISK DECLASSIFICATION SOFTWARE

UniShred Pro ($829 per workstation) provides U.S. Government–approved declassification of confidential materials from Unix workstation disks. UniShred overwrites all device-addressable sectors using direct SCSI commands. All Unix boot files, super blocks, swap space, file system partitions, and alternate cylinders are overwritten. The product is available for the Hewlett-Packard 9000 series with HP-UX 9.x, IBM RS/6000 with AIX 3.x, and Sun Microsystems' SPARC with SunOS or Solaris 2.x.

Contact: Los Altos Technologies, Los Altos, CA, (415) 988-4848.

Circle 1264 on Inquiry Card.

ENTERPRISE SNMP CSU/DSU FOR 64 KB AND 56 KB

The 6406-S CSU/DSU lets you see your entire network from a host site. Each unit features an embedded MIB II agent that monitors and maintains performance parameters and provides access to testing and loopbacks. The ATL 6406-S provides real-time SNMP alarm messages, allowing full access and control of an enterprise network in a low-cost 64-KB or 56-KB CSU/DSU. The unit offers DDS speeds with either a 10Base-T or an AUI Ethernet interface ($1395) or a serial interface ($1195).

Contact: American Technology Labs, Ijamsville, MD, (301) 695-1547.

Circle 1265 on Inquiry Card.

UNIX VIRUS DETECTION

Now you can request virus scans for Windows- and DOS-based workstations on Unix networks. Sophos has ported its Sweep scanner (£495 for 25 users, £895 for unlimited users) to Unix, adding to the NetWare, Windows NT, OS/2, and Open VMS platforms now supported. Users run the Intercheck client that sends virus checking requests to Sweep on the main server. Sweep runs in a "SoftPC" PC emulation mode, feeding requests back to the workstation. This lets Sweep run on Banyan Vines and Artisoft LANtastic networks.

Contact: Sophos, Oxfordshire, England, +44-1235-559933.

Circle 1266 on Inquiry Card.

SPARC 20 CLONES

Integrix offers two SparcStation 20–compatible workstations. Both have 100-MHz quad HyperSparc processors from Ross Technology and a newly designed chassis that supports up to two internal hard drives, one floppy drive, and an internal CD-ROM drive. A complete SWS20 system based on the 100-MHz HyperSparc CPU, 32 MB of memory, a 1-GB hard disk, and a 17-inch color monitor lists at $10,495. The SWS20 features an integrated 24-bit SX graphics card with 8-bit overlay; the addition 4 MB or more of video memory activates the 32-bit SX graphics. The SWS-20E features an ISDN interface for high-speed data transfer and lists at $9995.

Contact: Integrix, Newbury Park, CA, (800) 300-8288 or (805) 375-1055.

Circle 1268 on Inquiry Card.

X11R6 PC X SERVER FOR NT

Exceed 4 for Windows NT ($545) provides X11R6-compliant PC X Window System–server capabilities, letting Windows NT users on Intel, Alpha, and MIPS platforms access Unix, VMS, and other X-based computers and applications. Exceed 4 includes a scripting language (Exceed Basic) and dial-up capability for remote access to Unix- and X-based applications over standard telephone lines. Also included is password protection of X-server configuration settings and remote configuration administration, enabling automatic configuration and installation of Exceed on multiple PC desktops. Using the Tektronix Serial Xpress Protocol (SXP), Exceed provides remote file transfer and printing of Unix files on home-based PCs and printers.

Contact: Hummingbird Communications, Markham, Ontario, Canada, (905) 470-1203.

Circle 1269 on Inquiry Card.

WIDGETS FOR QNX

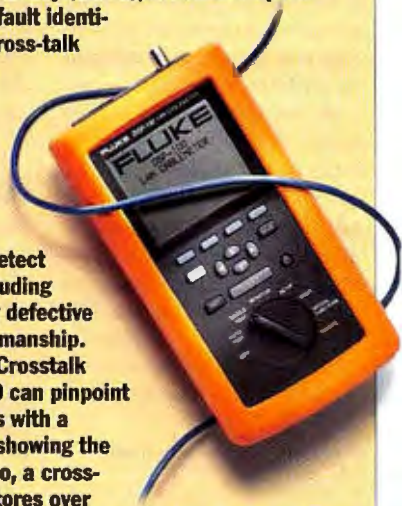
The KL Group has ported its XRT/3d ($2495), XRT/graph ($1995), and XRT/table ($1495) widgets to the QNX real-time operating system. XRT/graph is a powerful 2-D graphing widget that aids in creating bar charts; *x,y* plots; pie charts; area graphs; financial graphs; and logarithmic scientific charts. XRT/3d is a sophisticated 3-D surface, bar, and contour graphing widget for X Window System applications developers. XRT/table lets developers and end users display and manipulate tabular data in OSF/Motif applications.

Contact: The KL Group, Toronto, Canada, (416) 594-1026.

Circle 1270 on Inquiry Card.

HAND-HELD DIGITAL CABLE METER

A hand-held tool designed to test installed Category 5, ISO, and IEC LAN cabling to 100 MHz is available. The DSP-100 ($3795) uses DSP (digital signal processor) technology to provide extremely high accuracy (±2dB), faster test speed than analog devices, and fault identification with location of cross-talk faults. The DSP-100 performs a one-button pass/fail autotest in less than 5 seconds for NEXT (near-end cross talk) and other parameters in installed Category 5 cabling. The DSP-100 can detect the location of faults, including NEXT problems caused by defective components or poor workmanship. Using TDX (Time Domain Crosstalk Technology), the DSP-100 can pinpoint these or other NEXT faults with a graphical representation showing the amount of, and distance to, a cross-talk fault. The DSP-100 stores over 500 autotest results for downloading to a PC or printer with the provided DSP-Link software. The unit comes with a rechargeable nickel-cadmium battery.



Contact: Fluke, Everett, WA, (206) 356-5500.

Circle 1267 on Inquiry Card.



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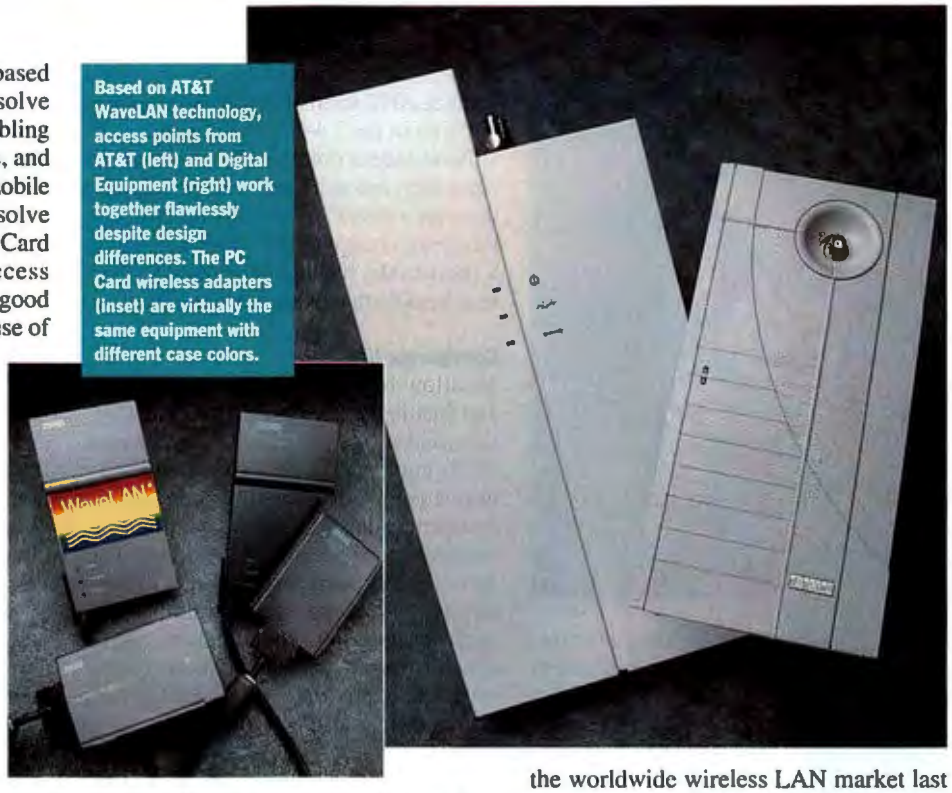
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Circle 79 on Inquiry Card.

Local Air Networks

WaveLAN wireless LANs offer robust range, throughput, and roaming

REX BALDAZO



Based on AT&T WaveLAN technology, access points from AT&T (left) and Digital Equipment (right) work together flawlessly despite design differences. The PC Card wireless adapters (inset) are virtually the same equipment with different case colors.

Although slower than wire-based networks, wireless LANs solve several knotty problems: cabling restrictions, frequent reorganizations, and most recently, networking of highly mobile employees. Current wireless LANs solve this last problem with PCMCIA PC Card adapters and roaming-enabled access points—two technologies that take good advantage of the growing corporate use of portable computers.

Equipped with PC Card wireless LAN adapters, notebook-toting workers, for example, can set up ad hoc peer-to-peer networks at meetings or off-site locations and work collaboratively over the air waves. Through radio-equipped access points with roaming capability, the same group (or groups) can also stay tied into the office LAN for file and print services and move seamlessly from access point to access point without concern of losing that all-important network connection (see the text box "On the Roam" on page 206).

We tested two wireless LAN systems with roaming-enabled Ethernet access points, from AT&T and Digital Equipment. Both are based on AT&T WaveLAN technology, provide similar performance, and are interoperable. They are not easy to set up, and bandwidth is still limited (2-Mbps, raw data rate), but for many applications, you won't notice the lower throughput. You may not even mind the higher price (about $900 per station, depending on size and configuration), if you can take advantage of the benefits of wireless networking as it was meant to be.

Old Champ

WaveLAN is the oldest wireless LAN technology that works in an unlicensed radio band yet still provides more range and throughput than its more recent competitors. WaveLAN technology uses a direct-sequence spread spectrum radio operating at 915 MHz in the 902- to 928-MHz ISM (Industrial, Scientific, and Medical) bandwidth. A number of vendors have licensed WaveLAN technology to use in their own wireless LANs, including Digital, Solectek, and Persoft.

WaveLAN, however, is not the wave of the future, mainly because the 902- to 928-MHz bandwidth isn't available outside of Canada, the U.S., and Mexico. The 2.4-GHz ISM bandwidth (2400 to 2483.5 MHz) is available internationally, and several companies' wireless LANs operate in that bandwidth already. Other companies including AT&T plan to have their products in that bandwidth as well. Further, the IEEE 802.11 committee is slowly developing an interoperability standard for 2.4-GHz wireless LAN products (see "Universal Wireless LANs," May 1994 BYTE). Broadcasting at a higher frequency, 2.4-GHz products don't have the range that the 915-MHz WaveLAN does. International signal power restrictions can further limit the range.

While the 802.11 specification firms up (maybe in 1996), you can achieve interoperability of a sort with products based on AT&T's WaveLAN technology. It's not going away anytime soon. According to Becky Diercks, program director of Wireless Research at Business Research Group, the worldwide wireless LAN market last year was about $100 million, with AT&T and its licensees controlling some 40 percent of that.

Family Affair

AT&T produces Type II PC Card radio transceivers that are part of both its own WaveLAN product and Digital's RoamAbout line. Both also offer ISA-bus-based transceiver cards for desktop systems. Solectek, another WaveLAN licensee, sells a WaveLAN-based parallel-port adapter for older portables. Except for color, the WaveLAN and RoamAbout PC Card radios are essentially identical, including their $695 price. We could even use the Digital enabler software to get the AT&T radios operational.

An external antenna the size of a deck of playing cards connects to the PC Card adapter via a short cable. The antenna sits in a clip holder that attaches to the clamshell lid of your notebook computer with two small adhesive pads. Thanks to the clip arrangement, you don't have a bulky antenna permanently attached to your computer. A PC Card with an integral antenna

PHOTOGRAPHS: LARRY DUNN © 1995

would be nice, but it isn't feasible for the 915-MHz radio bandwidth, because the antenna must be relatively large. (Xircom's 2.4-GHz PC Card transceiver is the first to use an integral antenna.)

It's in their access points that the two products differ. They have different cases,



The omnidirectional antenna for a WaveLAN-based LAN adapter is held by a clip to the lid of a notebook. Adhesive patches permanently attach the clip, but you can remove the antenna. Open air range is 800 feet.

microprocessor controllers, management software, and radios. But AT&T and Digital, along with Solectek, have cooperated to keep their access points interoperable.

AT&T's 286-based WavePoint is clearly the older of the two. To link up with a wired LAN, the bulky white box includes connections for thick, thin, and twisted-pair Ethernet, with DIP switches determining which connection is active. The radio for communicating to the wireless stations is built into the WavePoint, with a long external cable connecting to a separate wall-mountable antenna. In fact, the WavePoint itself can be wall-mounted.

Digital's RoamAbout Access Point is also wall-mountable but in a smaller and more stylish box. The box can also fit into a DEChub90 or DEChub900, two modular Ethernet hubs from Digital. The RoamAbout box has only thin and twisted-pair Ethernet connections but doesn't require setting DIP switches to identify the active connection. According to Digital, a Motorola 68360 processor gives the RoamAbout unit a performance edge over the AT&T access point when the wired LAN undergoes heavy traffic.

Instead of a built-in radio transceiver, the RoamAbout Access Point has a single PC Card slot that takes the same radio unit as the client stations. This modular design provides for upgrades to future radio technology (i.e., 2.4 GHz) or to other existing wireless LAN products. In fact, this month, Digital provides a software upgrade that allows the RoamAbout Access Point to use WaveLAN or RangeLAN2 cards and automatically configures to whichever type of transceiver card is in the slot. Proxim's RangeLAN2 technology uses frequency hopping in the 2.4-GHz bandwidth.

New access points will ship with this capability, and older units can be upgraded through a BootP process. A downside to this design is that the PC Card radios have a short cable, making antenna placement less flexible than with the WavePoint.

Configuring IDs

To allow overlapping of coverage cells and roaming between cells, wireless stations and access points use a combination of ID numbers. Each access point must have a unique *network ID* so that stations communicating with that access point can unambiguously identify their packets. This allows access point coverage areas to overlap while keeping packets intended for each access point separate. Network ID doesn't matter for client stations except for ad hoc networks without an access point—then all stations must have the same network ID.

To identify that they are all part of the same greater network, all access points and client stations share a common *domain ID*. The domain ID is transmitted publicly, so for security, the access points and stations must also have a common *beacon key*, which is encrypted in transmissions. The domain ID and beacon key signify membership in the same extended infrastructure network, and client stations can move freely between access points without losing their network connections.

Setting these IDs is a big part of the WaveLAN configuration process. While AT&T's and Digital's access points have blinking LEDs to indicate status, neither has any sort of control panel for setup. Instead, you use a separate workstation to configure them, and here is one place where the two companies differentiate their offerings.

With Digital's RoamAbout Access Point, you connect a serial cable from a computer and using a terminal program, access a series of text menus to set IDs and roaming parameters. We had no problem using the Windows Terminal program to do this. With AT&T's WavePoint, you perform setup through a LAN connection, either wired or wireless, using a program called the Configurator. The wired LAN approach is easier to set up than Digital's approach because you don't have to find and attach a serial cable.

If you choose to set up the access point from a wireless station, however, you're in for trouble. To get the station up and running, AT&T offers a batch file that creates a boot disk with the necessary wireless LAN driver and configuration parameters. Once you have booted the station with the disk, you run the Configurator to define a configuration file and upload it to the access point. Unfortunately, the boot disk sets your workstation to one network ID and the WavePoint comes set to another, so the WavePoint ignores the transmission.

You must edit a file on the boot disk to correct the network ID and then reboot and upload the new configuration. Of course, if the new configuration includes a different network ID, you must modify the boot disk again to the new ID so that the next time you use the Configurator, it will use the new network ID. Most of this should be handled automatically, perhaps by the Configurator itself. Until this problem is fixed, you should upload the access point configuration file over the wired network.

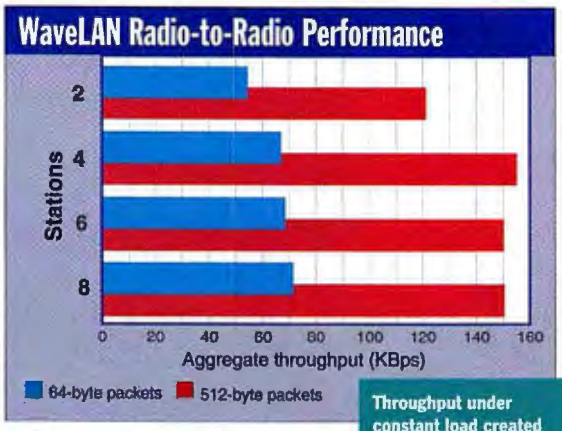
It Gets Worse

Documentation for both products is abysmal, and in at least one instance, it's plain wrong. The Digital RoamAbout Access

FILE TRANSFER PERFORMANCE AND ROAMING

Moving large files is a weak point for wireless LANs. Compared to transmission on a 10Base-T LAN, transfer of a large file (4,027,556 bytes) to a wireless WaveLAN station took more than eight times longer. Wired/wireless performance differences with other types of operation won't be as dramatic. Moving the file between stations in different access point cells added a 6 percent delay to the transfer. The case with roaming adds the further delay it took for a station to hand off from one access point to another. Results for AT&T and Digital LANs were essentially identical with low traffic on the wired part of the LAN (the test conditions).

	TIME (S)	THROUGHPUT (BYTES/S)
Wired to wired	16	251,722
Wired to wireless	132	30,512
Wireless to wireless	139	28,975
Wireless to wired to wireless	148	27,213
Wireless to wired to wireless (roaming)	153	26,324



Throughput under constant load created and measured by NSTL's low-level packet blaster program. With the larger (512-KB) packet size, aggregate throughput saturated with four active stations. Performance was identical for AT&T and Digital wireless LANs under our test conditions (all stations in a single cell).

Point manual states that you use hexadecimal values to set certain roaming thresholds, but the setup program actually requires decimal values.

Digital's PCMCIA radios have no installation program. You have to manually copy the programs over, add a line to your CONFIG.SYS file to run the enabler program, and make sure your extended memory manager excludes the memory window that the adapter uses. If you run Windows, you have to add an EMMExclude line to the 386Enh section in your SYSTEM.INI file to exclude the same memory window. A simple install program should handle all this.

AT&T provided a batch file that copied files over and another batch file to create the Configurator boot disk. But after that, you had to walk through the exact same steps as with the RoamAbout.

Installation under NetWare can be problematic for both products because of inadequate documentation. Both manuals describe how to add domain ID and beacon key statements to your NET.CFG file, but they don't mention that you should place the statements directly after the Link Driver statement or that you should indent them from the left margin. Less experienced NetWare users would certainly appreciate a couple of explanatory sentences added to either company's manual.

Home on the Range

Once configured, we tested roaming with the AT&T and Digital LANs under both Windows for Workgroups 3.11 and NetWare 3.1. Supplied with NDIS and ODI drivers, both products work with any DOS- or Windows-based NOS (network operating system). Under WFW, because there were no installation programs, we had to manually set the domain ID and beacon key in the PROTOCOL.INI file. After that, we were able to move between access point coverage areas without dropping the connection and without significant performance degradation.

To test the WaveLAN and RoamAbout products, we acquired eight PC Card adapters and two access points from each manufacturer. For client stations, we used a variety of notebook PCs: one 486DX4 and one Pentium each from DTK and Micro International, two Toshiba T1910s (486SX), a Toshiba T4900CT (Pentium), and a Toshiba T2150CDT (486DX4). Unfortunately, the WaveLAN and RoamAbout systems require complete Intel PCMCIA chip-set compatibility, which kept us, for example, from using two Business Audio notebooks from Austin Direct (Databook PCMCIA chip set).

For planning layout of access points, both WaveLAN and RoamAbout products come with software that lets you use a wireless station as a monitor to test signal quality. You can monitor both access points and other wireless stations. We used it to verify that we had overlapping coverage between access points and to confirm that open-air range met the manufacturers' claim of 800 feet. It did (over 900 feet, actually). We also found a hand-held network tester worthwhile to determine if initial setup problems came from an access point itself or its connection to the wired LAN. Microtest's Compas tester saved many hours of hair pulling.

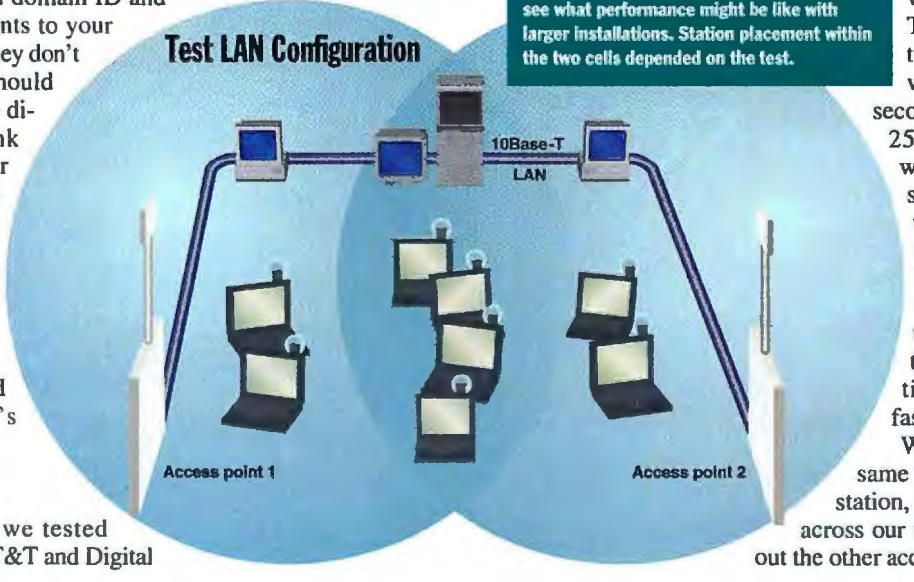
The BYTE editorial offices occupy a 45-year-old building with a mixture of fairly solid interior walls and large open areas divided into cubicles with 5-foot-high partitions. Two WaveLAN stations placed 150 feet apart at either end of the building were just out of range so that our roaming test setup with two access points was appropriate.

We tested with two active access points in three different configurations: two AT&T WavePoints, two Digital RoamAbout Access Points, and with one of each. We measured no significant throughput differences between file transfer tests with the AT&T and Digital products, so the file transfer performance numbers involving two access points represent the case where we had one of each type of access point. WaveLAN and RoamAbout radios also performed identically, so we could mix and match adapters during testing.

To provide an idea of how WaveLAN compares to standard wired Ethernet, we transferred a fairly large file between a variety of combinations of wired and wireless stations. Throughput between two wireless stations was 28,975 bytes per second, well below the 251,722 Bps we got when moving the same file between two stations on our unswitched 10Base-T network. Data transfer speed between a wireless station and a wired station was somewhat faster at 30,512 Bps.

We then moved the same file from a wireless station, to the access point, across our wired network, and out the other access point to another

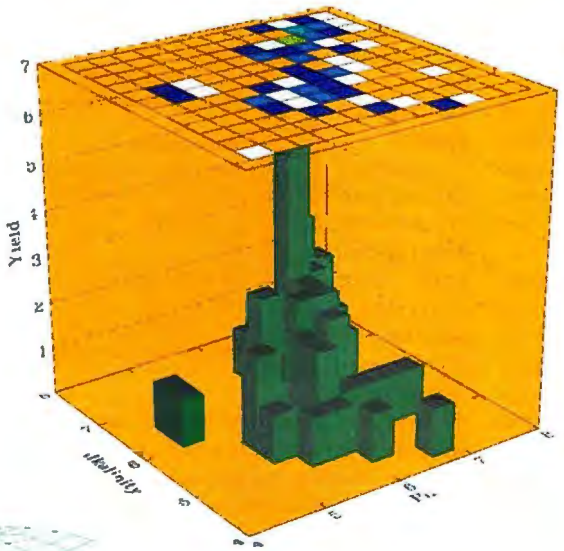
Using two access points allowed testing of wireless roaming capabilities. By generating network traffic with as many as eight client stations within a cell, we could also begin to see what performance might be like with larger installations. Station placement within the two cells depended on the test.



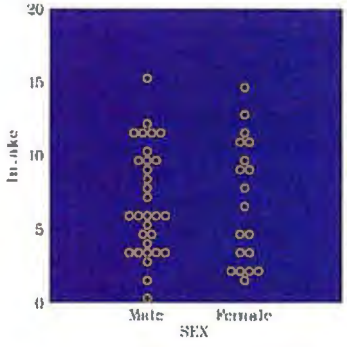
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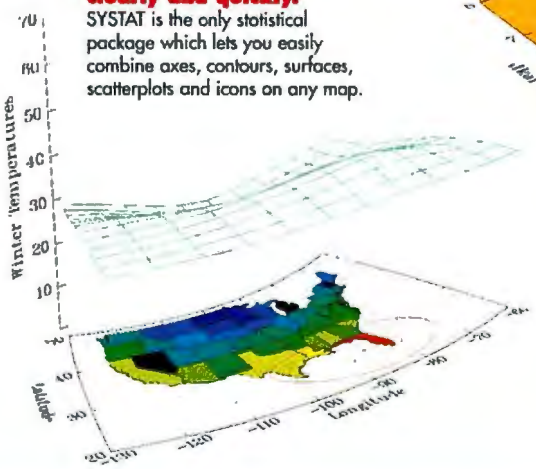
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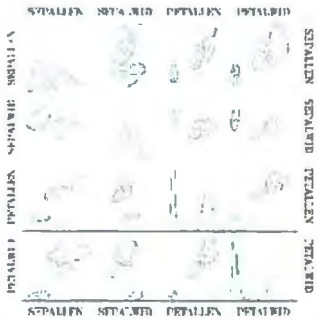
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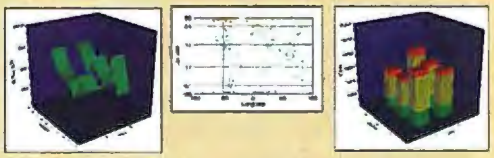


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wireless station. Overall throughput in that case was 6 percent less than the wireless-to-wireless case. We also tried this test while moving one of the workstations between the access points. Performance was slightly reduced, but we were impressed by how well the products handled roaming, especially when we tested with an AT&T WavePoint at one end and a Digital RoamAbout Access Point at the other (see the table "File Transfer Performance on page 202").

To estimate how quickly wireless stations could saturate the available bandwidth within a wireless cell we gauged throughput with different numbers of active stations. To measure throughput, we ran a low-level IPX test developed by NSTL that blasts IPX packets between pairs of stations. We tested with one pair of communicating stations and then two, three, and finally four pairs all simultaneously blasting IPX packets. We also varied the size of the IPX packets, first using 64-byte and then 512-byte packets.

Aggregate throughput hit the wall with just two pairs (four stations). Adding stations beyond that reduced the individual throughput between pairs of stations without increasing aggregate throughput. Using bigger packets increases throughput. With 512-byte packets, measured throughput was twice what it was with 64-byte packets.

Power consumption is an important consideration with wireless adapters, especially for more mobile stations. We ran the BYTE battery test with our Thumper II test system on a Toshiba T4900CT (a 75-MHz Pentium notebook), both with and without a WaveLAN adapter plugged in. Without the adapter, the Toshiba ran for 4 hours and 15 minutes. With the LAN card plugged in and not actively broadcasting, the Toshiba's batteries lasted just 3 hours and 5 minutes, a substantial drop. Because WaveLAN acts in peer-to-peer fashion even when using access points, implementing power management is difficult, and neither company does it.

Product Information

RoamAbout
RoamAbout PC Card Adapter.....$695
RoamAbout Access Point....$1795
Digital Equipment Corp.
(800) 457-8211
(508) 692-2562
fax: (508) 392-0603
Circle 979 on Inquiry Card.

WaveAround
WaveLAN PC Card Adapter..$695
WavePoint Access Point....$1995
AT&T Wireless Communications & Networking Division
(800) 288-9283
fax: (513) 445 5552
Netherlands: +31 3402 97554
fax: +31 3402 97555
Circle 980 on Inquiry Card.

Limited Performance

It isn't a surprise that wireless LAN performance wasn't up to par with a wired LAN. However, we were surprised by how quickly we reached the limits of the wireless LAN. With only four stations actively sending packets back and forth, we had effectively reached saturation. Adding stations brought no additional bandwidth, it just reduced each station's available bandwidth while keeping the aggregate throughput the same. Under more normal usage patterns, it would take more stations to saturate WaveLAN.

What's great about AT&T WaveLAN and Digital RoamAbout is that they work well together. We expected the PC Card radios to interoperate because they are identical; however, we were pleasantly surprised at how well the access points worked together, letting us roam back and forth between the two implementations.

In comparing the two, the edge goes marginally to Digital's RoamAbout. Both vendors have lousy software setup and painfully incomplete documentation. We liked the fact that the RoamAbout Access Point used the same PC Card radio as the rest of the wireless stations and can take other types of radios. Digital's access point setup was easier than AT&T's somewhat byzantine WavePoint setup process. But because they interoperate so smoothly, you can just pick and choose the pieces of each that you like. ■

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On the Roam

DAVE ROWELL

Until recently, access points limited the mobility of wireless stations. To stay connected to a wired LAN through an access point, a station had to remain within range of that particular access point. Even if you had a number of access points set up into a sort of cellular network covering your entire facility, you couldn't actually roam and remain connected because there was no capability to automatically hand off from one access point to the next.

To allow roaming, WaveLAN-based access points use a combination of advertising to client stations and coordinating among themselves. The advertising is in the form of message frames called *beacons*, which the access points broadcast every 200 milliseconds or so. Beacons contain the domain ID, the beacon key, and the access point's network ID, the last two encrypted together.

Clients decide which access point to attach to based on signal strength. When a client registers with a new access point, its sign-on request message includes the network address of its old access point. The new access point can then notify the old of the change so that packets addressed to the client will arrive at the right destination.

To prevent periods of reduced throughput from lost frames, WaveLAN-based clients switch access points before transmission drops off. The switching process uses a set of rules with three configurable signal strength thresholds so that switching occurs in time, but not unnecessarily. When the signal-to-noise ratio of transmissions from the current access point drops below 24 percent, a station goes into a promiscuous mode.

It's still getting 100 percent of access point transmissions, but the station starts decoding other access point beacons and will register with another access point if the signal-to-noise ratio is 30 percent or higher. This higher threshold ensures that a station doesn't bounce back and forth between two access points with similar signal-to-noise ratios, thereby degrading performance.

If the signal-to-noise ratio drops 18 percent, a point close to where frames start dropping, a station goes into a fast search mode. Now it will accept any access point providing a signal-to-noise ratio greater than 24 percent. Again, the higher threshold provides a hysteresis effect that prevents bouncing.

Dave Rowell is a BYTE technical editor. You can reach him on the Internet or BIX at drowell@bix.com.

Oracle Hits the Road

Oracle Mobile Agents take over network transactions so that wireless clients can get to corporate data in seconds

PETER WAYNER

Many people who tend to work "in motion" know the siren call of wireless networking, but until recently, there have been few products that simplify the technology. Creating a wireless network is not as simple as taking a traditional network and replacing the wires with radio transceivers. Old network protocols don't work well in the radio environment, which is susceptible to weather, noise, crosstalk, and other demons of the ether.

Now that the technical hurdles of wireless data transmission are becoming well understood, software makers are helping programmers tap the power of wireless networks. One of the first to do so is Oracle (Redwood Shores, CA), whose Oracle Mobile Agents toolkit essentially solves the problem of shuffling information between distant, wireless clients and corporate database servers. The toolkit can handle communication with any program, not just Oracle's database products.

Agents in Motion

Oracle Mobile Agents is structured around a client-agent-server model that interposes a software agent between client and server (see the figure "The Client-Agent-Server Paradigm"). The agent runs on the server machine and is responsible for handling requests from off-site clients. It then takes the requests and gets answers from the server. Ideally, the agent programmer can incorporate enough intelligence in the agent to significantly reduce the amount of network traffic between the server and the client.

Many protocols that run over wired networks often exchange several messages to establish a connection before processing any information. This is fine when the speed of the network is blindingly fast, but it fails quickly on wireless networks, which often require 2 to 4 seconds to transmit a single packet. The Oracle Mobile Agents' job is to roll all this interaction into one packet. (For a more detailed breakdown of the different transmission media's response times, see the figure "Speed in Response Time" on page 208.)

Oracle's definition of an agent is different from General Magic's (Mountain View, CA), the creator of the heavily anticipated agent language Telescript, which at the time of this writing was still unavailable to the general public. Telescript is virtually a full-fledged OS, with agents roaming around in it that are themselves full-fledged programs capable of interacting with each other. Oracle takes a simpler, more evolutionary approach. Its agents are simply plug-in software modules that programmers can use to add functionality to Oracle Mobile Agents. These agents can't roam from machine to machine: They are closer to Adobe Photoshop plug-ins or applets than they are to full applications.

This lack of functionality is not much of a handicap. Some people might even call it a feature. The Telescript approach is clean and thorough, but it can be overkill for simple applications. Oracle Mobile Agents lets you choose the right amount of power for your purposes.

On one end of the scale might be a simple "Hello, world" agent that will respond to any message with the string "Hello, world," all done in 200 lines of C code. The result would have none of the generality or complex authentication features bound up in Telescript, but it would do the job. On the other end of the complexity scale might be an agent with a built-in parser and interpreter that will accept arbitrarily complex programs as messages.

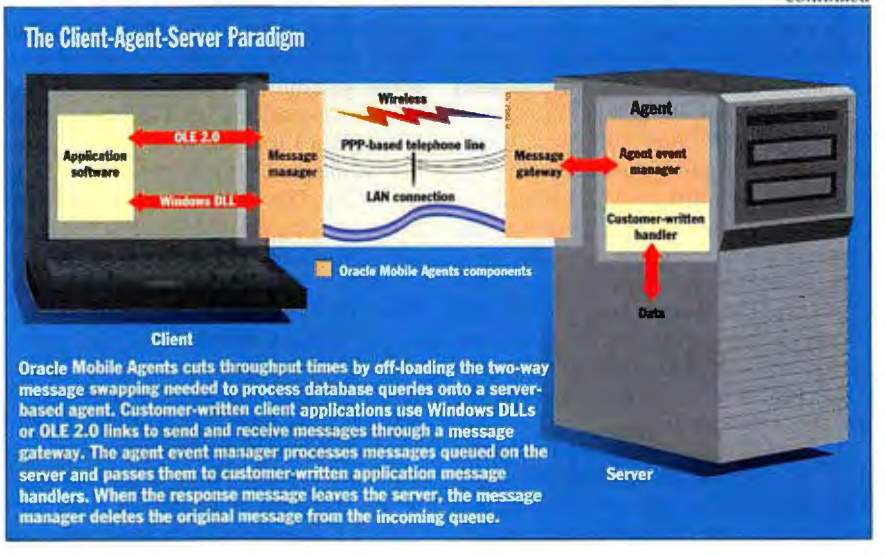
After you write the agent, Oracle Mobile Agents takes over the handling of the data between the wireless network and the server. It aggregates the incoming packets until the complete message is available. If transmission glitches garble the data, the software handles getting new copies of the missing or scrambled packets. When the message is complete, Oracle Mobile Agents fires up the correct agent and hands it the message. This makes life easy for programmers because they need to write only agent code that accepts a full-formed message.

Using the Toolkit

Oracle Mobile Agents comes with two major development components. One lets you create agents for Unix systems, and the other lets you build both agents and clients running on Windows machines. The Unix agents, which run as processes, access a central message gateway that interfaces with the radio network. Time-sharing between multiple agents running on the same server is handled by whatever Unix variant is serving as your OS. Users with bigger databases or more-complicated installations will probably choose to run Unix on their server.

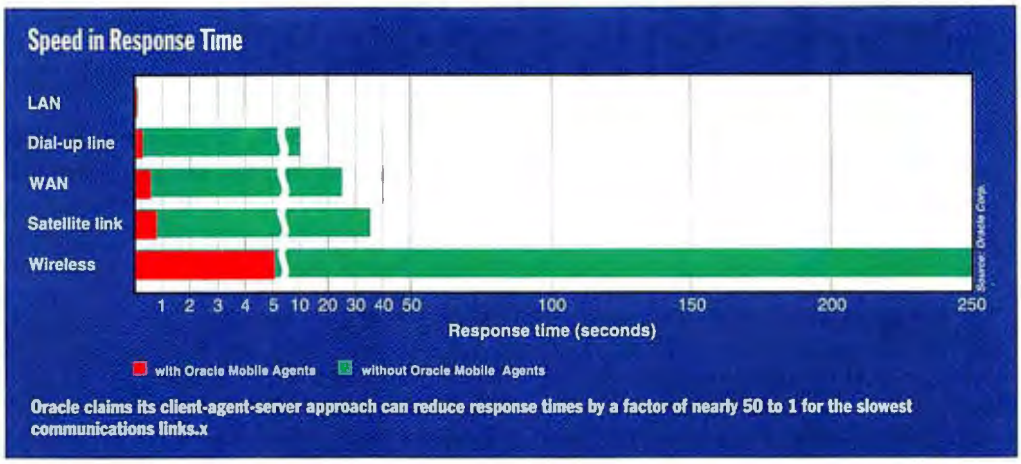
You can use the Windows development component to create clients and agents.

continued



Oracle Mobile Agents cuts throughput times by off-loading the two-way message swapping needed to process database queries onto a server-based agent. Customer-written client applications use Windows DLLs or OLE 2.0 links to send and receive messages through a message gateway. The agent event manager processes messages queued on the server and passes them to customer-written application message handlers. When the response message leaves the server, the message manager deletes the original message from the incoming queue.

The core is a message manager that runs as a separate application. When client-based applications want to access distant agents, they communicate with the message manager by either calling functions in a Windows DLL or passing an OLE 2.0 object. The message manager handles the chores of communicating with the distant agents. The manager is flexible because it can communicate using a wireless network, phone lines running PPP, or a standard LAN. This gives better service to people who have a wired connection handy at a certain moment.



Oracle claims its client-agent-server approach can reduce response times by a factor of nearly 50 to 1 for the slowest communications links.x

Modifying your application to send messages to an agent is fairly easy. The application must create a connection by asking for the distant agent by name. (When the agent is started on the distant server, its name, IP address, and port number are published.) If the local message manager can find the agent through the wireless network, then the connection is established.

You must also arrange for information to flow from the message manager to the application by either initializing a DDE link or identifying an OLE 2.0 notification link. The server-based message manager will send any incoming traffic intended for an application through this path.

Once a connection is established, the application can pass messages back and forth to the agent with a simple procedure call or object transfer. Oracle Mobile Agents packs the data correctly and negotiates with the radio network to ensure that the data arrives.

For example, a program written in Microsoft Visual Basic can communicate with a distant agent with four straightforward commands. First, the program establishes a connection using the command `Set ConObject=GetObject("Agent Name", OLE_MM_CONNECT)`. Next, it creates a new outgoing message using the command `Set OutMessage=Binding_VBMxLib.GetNewOutGoingMessage`. The program packs the contents of the message using the command `OutMessage.PutVar`. The Visual Basic routines are smart enough to pack the messages correctly based on data types. Finally, the command `OutMessage.Send` sends the message on its way.

The rest of the application must contain code for interpreting arriving messages. This can be as simple or as complicated as your application demands. The structure of the basic code, though, is a simple case statement. The libraries for C are just as easy to use.

Oracle Mobile Agents comes with instructions for building these Windows applications using Visual Basic, various vendors' C/C++ compilers, Powersoft's PowerBuilder 3.0, or Microsoft's Excel 5.0. The manual also comes with a sample application that you can use as a skeleton for building the system. The Unix software comes with several sample applications that also make good skeletons.

Testing While in Motion

To test Oracle Mobile Agents, we used preexisting applications and wrote our own. First, Oracle allowed us to access a suite of simple programs written for internal corporate use, including an E-mail package, a stock quote server, and several other database applications. We then wrote the client packages in Visual Basic and loaded them on an IBM ThinkPad 360C notebook computer equipped with a Motorola InfoTac radio modem. We used Oracle's E-mail and stock link for several weeks in a variety of locations throughout Washington, D.C., Baltimore, and New York City. This approach also gave us experience using the RAM Mobile Data network, which shuttled requests between the ThinkPad client and the agent/server combination at Oracle's headquarters in Redwood Shores, California.

Product Information

Oracle Mobile Agents 1.0.....$747 and up
Oracle Corp.
Redwood Shores, CA
(415) 506-7000
Circle 976 on Inquiry Card.

RAM Mobile Data coverage is significantly broader and more reliable than it was when we tested it several years ago. The InfoTac modem was able to establish a link in most cases. But it would not work in the basement of a house in a hilly region of Baltimore or in the inner rooms of a New York City apartment. In both cases, the service worked fine when we moved the radio modem closer to a window.

During this period of intense use, the Oracle Mobile Agents software didn't trash messages, deliver bogus stock quotes, or mangle E-mail. Problems crept in only when we couldn't get a strong signal, a condition that was clearly indicated by a light on the modem.

We also created several simple agents, along with applications to call them. We wrote the agents in C by using the RAM Mobile Data network to talk to a Unix box at Oracle headquarters. For applications, we used Microsoft's Visual Basic on the IBM ThinkPad 360C. The process went without serious glitches. Anyone with some experience programming in either C or Visual Basic should find the software easy to use. The Oracle Mobile Agents team has obviously anticipated development problems and included a fair number of debugging features.

Wireless Made Easy

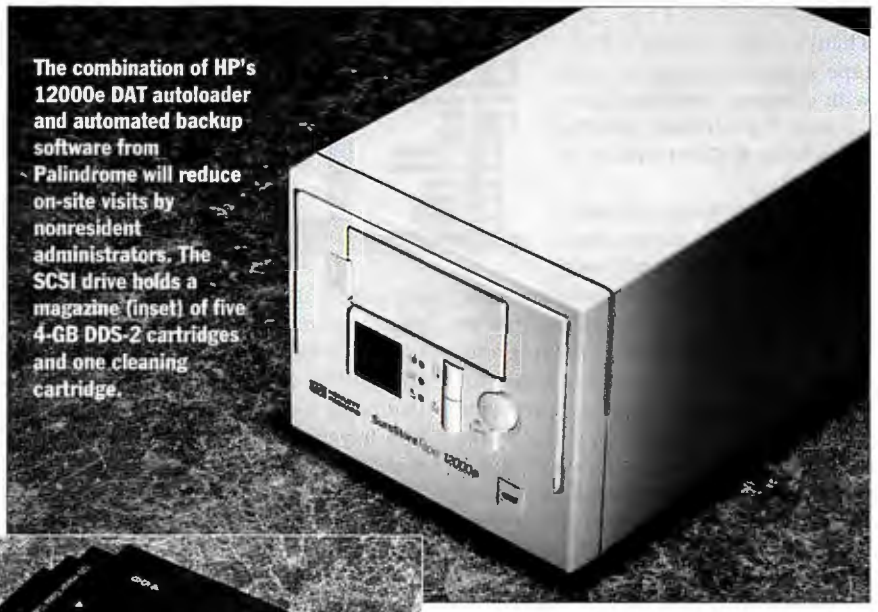
If you maintain a network server containing data that might be valuable to people who spend most of their workday away from phone lines, then Oracle Mobile Agents offers a reliable, fairly easy way to build a link between your network server and a wireless modem. You don't have to think deeply about roaming agents or complex network strategies. Oracle Mobile Agents' designers did the hard work for you. ■

Peter Wayner is a BYTE consulting editor and the author of Agents Unleashed *(AP Professional, 1995). He can be reached on the Internet at pcw@access.digex.com or on BIX at pwayner@bix.com.*

Hands-Off Backup

Bundled with Palindrome backup software for NetWare, HP's SureStore Tape 12000e DAT Autoloader can provide weeks of unattended network backup

BILL LAWRENCE



The combination of HP's 12000e DAT autoloader and automated backup software from Palindrome will reduce on-site visits by nonresident administrators. The SCSI drive holds a magazine (inset) of five 4-GB DDS-2 cartridges and one cleaning cartridge.

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Off-site administration of small LANs is becoming more and more common. With the networking of small businesses and corporate field offices, nonresident administrators and off-site consultants cleverly use remote control software, dial-up routers, or low-speed WAN links to manage the LANs in their care. These remote tools permit off-site administrators to manage LANs from afar in just about every way but one: Someone still has to be physically present to handle the mundane but vital task of changing backup tapes.

To help in this area, Hewlett-Packard has developed a loose product specification called LABS (Low Admin Backup for Servers), which combines an autoloading tape drive with highly automated backup software (see the textbox "HP Pushes Automated NetWare," March BYTE, page 148).

HP SureStore Tape 12000e LABS for Novell is the first product to implement LABS. It couples HP's SureStore Tape 12000e autoloading DAT (digital audiotape) drive with a custom version of Palindrome's NetWare-compatible Backup Director software, called Backup Director for the Workgroup. The 12000e is a DDS-2 DAT drive with a six-cartridge magazine. Presuming you use the magazine as it comes with five 120-meter, 4-GB tapes and one cleaning cartridge, you've got 20 GB of available storage, or around 40 GB with the 12000e's built-in data compression.

Backup Director takes advantage of the 12000e's automation features by handling tasks like tape drive cleaning and monitoring for problems. For example, the software automatically schedules restore and compare operations for periodic verification.

If problems occur, Backup Director can send alerts via NetWare's SEND command or MHS-compatible E-mail. The drive includes standardized alerts for common maintenance conditions, such as when a tape cartridge should be retired because it's reached the end of its duty cycle or because it's failed. The 12000e's high capacity coupled with Backup Director's completely automated management of backup sessions means you can run daily backups that need no attention for amazingly long periods.

High Capacity, Low Price

The 12000e is an external SCSI drive that comes housed in a 5.25-inch full-height case. Its easy-to-read LED front panel displays the drive's current status, including which magazine cartridge is loaded. The 12000e is among the first drives to support the DDS-2 DAT specification, which calls for a cartridge capacity of 4 GB and a maximum sustained transfer rate of 510 KBps. The drive's built-in data compression typically doubles both those figures.

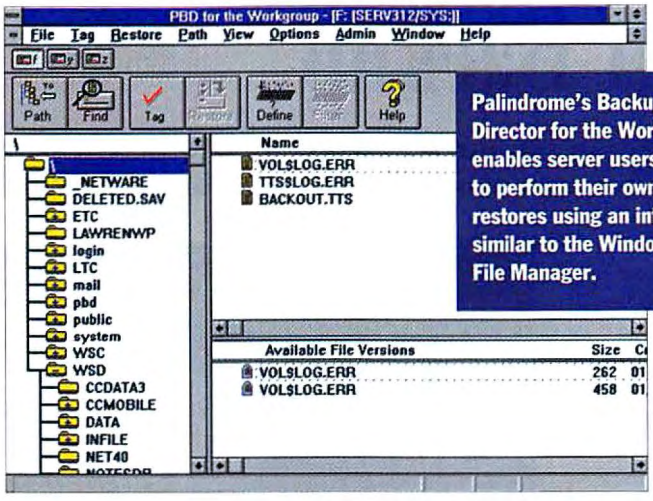
When used with Backup Director, the 12000e is directly connected to a NetWare 3.x or 4.x server with a SCSI controller (and a driver that's ASPI [advanced SCSI programming interface] compatible). In our tests, the primary server was a 486DX/33 PC with an ISA bus and two 400-MB IDE drives. Connected to an Adaptec 1543 ISA controller, the 12000e backed up at speeds averaging 25 MB per minute. Large restores went more slowly because Backup Director makes a special pass through the tape to restore directories first and then makes a second pass to restore files.

DDS-2 compares favorably with the popular 8-mm tape drives (precompression capacity of 5 GB to 7 GB and transfer rate of 500 KBps) from Exabyte, particularly when you consider cost per megabyte. Exabyte single drive units without autochangers typically sell in the mid-$3000 range, approximately the same price that you pay for the 12000e with its capacity leveraging autochanger.

Strategy Included

If you've got better things to do than master the intricacies of a full-featured backup program, you'll love Backup Director. Simply install the software on the same NetWare 3.x or 4.x server to which you've connected the 12000e autochanger, insert the tape magazine, and forget about it.

The Palindrome software automatically performs a full weekly backup of your server with daily incrementals in between. Backups start automatically at midnight, and after each week of backups, the Backup Director software repeats the cycle on a new tape. Thanks to the 12000e's five-tape magazine capacity (six with cleaning cartridge), you can store five iterations of backups without any intervention on your part.



Palindrome's Backup Director for the Workgroup enables server users to perform their own restores using an interface similar to the Windows File Manager.

While five weeks of unattended backups is enticing, leaving all your tapes and your server in the same room means your backup efforts will come to naught if fire or natural disaster strikes that room. Fortunately, Backup Director makes it easy for you to implement a weekly off-site tape rotation regimen. All you do is specify the day of the week when you want to switch your tapes, and when that day comes, Backup Director will prompt you to insert a new magazine.

Self-Service Restores

Since HP designed the 12000e LABS for Novell combo to liberate network administrators from having to physically attend to backup issues, it's only logical that the package should also free LAN managers from that most unscheduled interruption of them all—the file restore. As any experienced network administrator knows, the most frequent reason that files need restoration is not disk failure, it's pilot error—a user accidentally overwrites or deletes an important file and then needs to have it back.

Making good use of the HP autoloader, Palindrome's software empowers network users to perform their own restores through a Windows client program. The client automatically installs in the PUBLIC directory of the server, making it easy to launch. Using the program's File Manager–like interface (see the screen shot), users can browse for the files they need to restore, cruising through a database of backup sessions that Backup Director maintains on the server.

The Windows client includes a "recovery expert" that coaches you through the steps required to prepare and launch a file restore. You can also create sophisticated file-finding and filtering configurations that make it easy to pinpoint a file buried in a haystack of backup database information.

Backup Director could be easier to install, particularly on a NetWare 4.x server. With NetWare 3.x, the software installs easily enough. It automatically creates a user named BACKUP with supervisory access to the server, loads the appropriate NetWare target service agent module for your NetWare version, and it's ready for action. With NetWare 4.x, you have to create the BACKUP user yourself. And with NetWare 4.1, the installation process fails to load the correct target service agent, which means initial backup attempts fail until you manually load this module. With neither NetWare version does the install program offer to modify your server's AUTOEXEC.NCF file so that the right modules are automatically loaded every time you start the server.

Backup Director's ease of use comes at the sacrifice of some advanced features. Network managers, for example, can't use the backup software to move large groups of files from one volume or server to another. The program restores files only to the server and volume from which they were backed up. The HP SureStore/Backup Director combination is also a one-server-only solution. Though the Palindrome software complies with Novell's SMS (Storage Management System) specification, which provides for backing up any device running a target service agent module, you can backup only the server attached to the 12000e drive. That also means you can't back up drives on client workstations.

If these limitations bother you, there are or will be other backup packages available that support the 12000e. Palindrome offers its more fully featured Network Archivist, and Legato Systems has Staccato, a LABS product for the 12000e. Cheyenne Software is adapting ARCserve for use with the 12000e, as is Arcada Software with its Backup Exec for Windows NT.

That Just Released Feeling

BYTE received a 12000e LABS package about two months after Hewlett-Packard first started shipping this hardware/software combination. We quickly discovered a bug that seemed to prevent recovery under some circumstances from the most severe of hardware emergencies—the complete failure of a server disk volume. Though you would normally call your HP dealer to solve a problem, we called HP tech support directly. A support technician responded promptly to our call but had no immediate answer to our problem, even though full-volume restores are generally urgent matters.

Hewlett-Packard and Palindrome later determined that we were running version 3.5 of Backup Director, which they stated was included only with the earliest shipments of the product. They supplied us with version 3.5a, which completely solved the problem. If you happen to buy the drive with Backup Director version 3.5, insist on getting an upgrade.

Despite a few maiden-voyage anomalies, the 12000e LABS for Novell package with its Backup Director software bring unprecedented ease of use to a network task that is long overdue for simplification. ■

Product Information

HP SureStore Tape 12000e LABS for Novell
(includes Palindrome BackupDirector for the Workgroupsoftware)....$4650
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Bill Lawrence is part of a team that manages a 2800-node network for a major Western utility. He is the author of Using NetWare 4.1 *(Que, 1995) and* Using NetWare 3.12 *(Que, 1994). You can reach him on the Internet or BIX at blawrence@bix.com.*

Better Business Processes

A customized linked spreadsheet gives Process Charter for Windows the smarts that plain flowcharters lack

DAVID ESSEX

Flowcharting, like outlining, is one of those things you should have taken more seriously in college. When faced with the chaos of work in the Age of Downsizing, you come to realize that, far from being a pointless exercise, flowcharting can be the best way to conceptualize a process that needs fixing.

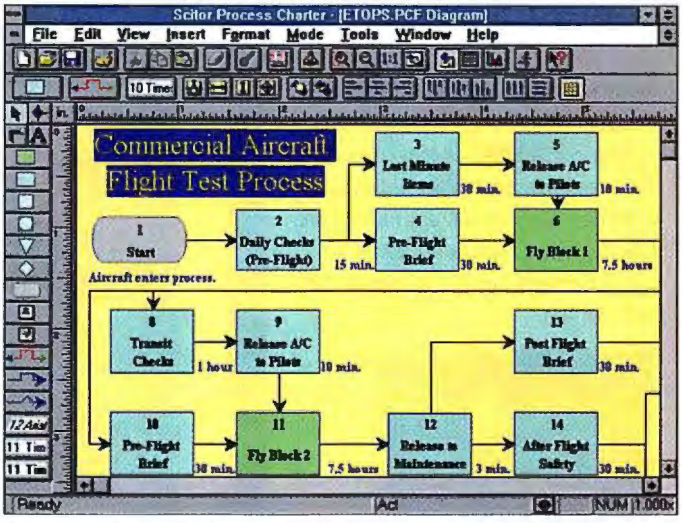
Scitor Corp. has hit on an absurdly simple idea. Instead of merely making a robust set of graphical flowcharting tools and offering links to spreadsheets, Scitor has coupled an actual, process-optimized spreadsheet to the drawing tool. The result is Process Charter, an easy-to-use program that lets you simulate processes depicted in the flowchart.

We used Process Charter to design a half-dozen flowcharts depicting various editorial processes, both existing and wished-for. We ended up throwing most of them out, learning much about the proper uses and key limitations of Process Charter along the way. (The moral: make sure you've clearly designated the entities that flow through the system; or, a system framework does not a simulation make.) We ended up converting an existing paper flowchart of a BYTE article's flow through the magazine's editorial, design, and production departments. A work in progress, this imposing chart is potentially an important tool for editorial management.

Discrete Events and Queuing

Process Charter is a discrete event simulator. It calculates the state of the system elements at discrete points in time. At a higher level, systems are either *deterministic* or *stochastic*: perfectively predictable if all conditions are met, or relatively more random if some conditions are varied. Of the stochastic type, simulations may be either *continuous* or *discrete*, which are to each other what analog is to digital. In discrete models like those created by Process Charter, systems are profiled by taking "snapshots" of the system state at fixed intervals.

Hand-in-hand with discrete event simulation is the concept, often seen in computer science, of queuing. In the context of simulation, queuing is widely relevant because it models the basic input-process-output functions of all systems. But queuing in the same context also means lining up and (sometimes) waiting for service. Simulation textbooks often cite a classic queuing problem: customers lining up at a bank to wait for the next available teller. Not surprisingly, Process Charter comes with a sample bank-teller simulation, which is explained in the figure, "The Bank-Teller Queuing Problem" on page 212.



Scitor helped Boeing use Process Charter for Windows to determine that daily maintenance procedures would take 27 hours to complete unless some jobs were done in parallel. The flowchart and simulation were later used for training maintenance personnel.

It's not hard to see why queuing is a key concept in Process Charter. A case in point: in our article-flow simulation, queues can result if articles enter the system faster than any one component can process them. A queue then becomes a bottleneck to be avoided by redeploying resources. Process Charter gives you specialized Flow Model and Key Values spreadsheets (again, refer to the figure) for identifying bottlenecks by examining time values in cells.

Charting the Process

The first step in modeling a process with Process Charter is to create the flowchart. Here, the program works like a standard flowcharting tool. Toolbar icons and menu items let you access the three main views: diagram, spreadsheet, and graph. In the diagram view, the main control panel is a square on the left toolbar containing four small icons, each representing an entry mode: Select (for selecting a chart item for some additional operation); Figure, Line, and Text. We found ourselves relying on the mode buttons almost exclusively, even though most icon functions are duplicated in the drop-down menus, and a few functions (like line creation) are available via mouse control in other modes.

A palette of standard shapes (e.g., a diamond for a branching decision point, a parallelogram for input/output, etc.) sits handy along the left side. To use a shape, you click once on the palette icon, then point at the main window and click again to place the object. Connections between objects are most easily established by clicking in the middle of the originating object and dragging to the location of the destination object. An arrow will appear between the two figures. Alternatively, you can drag-and-draw lines in Line mode, but we sometimes found Process Charter too smart for its own good as it tried to figure out the best path between objects. Lines seemed to wrap unexpectedly around the far sides of objects, and one time, we ended up with a tangle of lines that looked too confusing. We could have used a menu command to delete all the lines, but we scrapped the entire chart instead.

Once you've got a dozen objects and lines on the screen, the ability to modify the configuration becomes critical. Here, Process Charter provides adequate tools, chief among them the ability to draw a box around an area and drag it. You can also reshape lines and make objects "snap to grid" so they line up with each other after your reference points have scrolled off screen. We did, however, find ourselves wishing for more intelligence in

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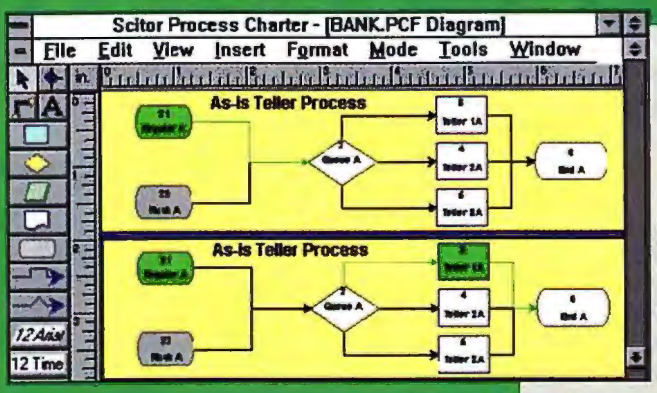
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The Bank-Teller Queuing Problem



Flow Objects

Name	Activity	ID	Resource	In	Remaining	In Work	Out	Avg Time
Customer				Unlimited	0	0	3	1m
	Queue A			1	0		1	0
	Teller 1A			1		0	1	1m
	Teller 2A			0		0	0	0
	Teller 3A			0		0	0	0
	End A			1	1			[1m]
	Regular A			Unlimited	Unlimited	0	1	0
	Rush A			Unlimited	Unlimited	0	0	0

Key Values

Description	Current	Baseline 1
Name	Standard Rate	Standard Rate
Time Last Run	26 Jan 20:34:04	24 Jan 15:44:31
Process Total Effort	6h 6m	2313m
Process Total Cost	$73.20	$462.50
Queue A Avg Wait	0.09m	6m
Long Process Time B Avg Wait		3m
Short Process Time B Avg Wait	0.1m	3m
Short Process Time C Avg Wait		0m
Long Process Time C Avg Wait	4.42m	25m
Regular A To Queue A Fixed Time	2m	3m
Regular A To Queue A Fixed Time	2m	3m
Rush A To Queue A Fixed Time	1m	1m 30s
Rush A To Queue A Fixed Time	1m	1m 30s
Regular B To Short Process Time B Fixed	2m	3m
Regular B To Long Process Time B Fixed	2m	3m
Rush B To Long Process Time B Fixed Tir	1m	1m 30s
Rush B To Short Process Time B Fixed Tir	1m	1m 30s
Regular C To Long Process Time C Fixed	2m	3m
Regular C To Short Process Time C Fixed	2m	3m
Rush C To Short Process Time C Fixed Tir	1m	1m 30s
Rush C To Long Process Time C Fixed Tir	1m	1m 30s

During the simulation run, Process Charter for Windows highlights the activities currently being performed (top). This run was stopped after the first two steps, and a Flow Objects spreadsheet generated (middle) to show the initial flow of objects through the activities (indicated by 1s). At the end of the simulation, totals and average times are calculated, then summarized in the Key Values spreadsheet (bottom).

the way Process Charter handles inserts. Rather than having to carefully draw a circle around a wide swath of objects to clear space for a new one, it would be nice to insert a figure and its associated lines and have the program move everything else down for you. It's the flowchart equivalent of the word processor's insert key, and it would save users the hassle of untangling lines and uncovering figures.

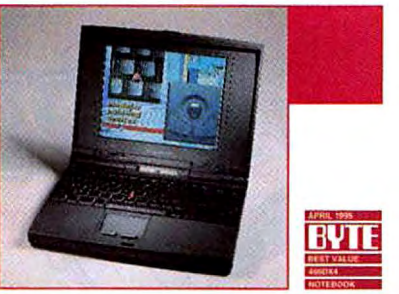
This is only a taste of Process Charter's flowcharting powers. There is a whole range of tools for changing colors, shading, typestyles, figure sizes, and so on.

The Smart Parts

The next step is to put some numbers behind the flowchart objects. For this, Process Charter offers a fairly clean input mechanism that does, however, come with a moderately steep learning curve. In a nutshell, you have to define resources (typically people and their pay rates) in the Resources spreadsheet, and then access the Activities dialog box to associate the resources to each action. When Process Charter runs through a simulation, it uses these definitions to quantify run times and costs. You also use the Activities box to establish the times (fixed or random within a range) that it takes to finish one task before going to the next one. Other variables in this box control such things as the size of the queue, routing choices, and timing flows through the system.

Click on the running-person icon, and up pop dialog boxes for setting up the simulation. Here, you choose the start and end times, as well as the seed value, which Process Charter assumes to be limited only by time unless you name a number. You can then either run the simulation at the predetermined speed or step through it; Process Charter highlights each activity as it is being activated. Speed seems to bog down, as you might expect, as the

Win a Notebook Computer!



BYTE's research department would like to know what your computer notebook requirements are. Please take a few minutes to fill in this form by July 31 and you will automatically be entered in the sweepstakes. The prize is this WinBook XP, a DX4-100MHz notebook.

Portable: a notebook or subnotebook computer weighing 8.5 lbs. or less.

1 Do you plan to purchase a portable computer within the next 12 months? *(Choose one.)*

Definitely yes ..... 1.
Maybe *(continue survey as if you plan to buy)* .... 2.
No *(continue survey as if you plan to buy)* ..... 3.
☐ Check here if you have purchased in the last six months

1A (If yes or maybe) Will this unit be paid for by yourself or by your employer?

Self (please go on to Question 2) ..... 1.
Employer (please go to Question 1B) ..... 2.

1B (If paid by employer) Approximately how many are employed by your company: *(Choose one.)*

1000 or more employees ..... 1.
500-999 employees ..... 2.
100-499 employees ..... 3.
50-99 employees ..... 4.
Fewer than 50 employees ..... 5.
Uncertain ..... 6.

2 Will you require CD-ROM with your next portable computer? *(Choose one.)*

Yes, internal CD-ROM, built into notebook ____ 1.
Yes, external CD-ROM, connected to port or docking station ..... 2.
No ..... 3.
Uncertain ..... 4.

3 For the unit selected above in question 2, what weight would you be willing to accept? *(Choose one.)*

4.5 lbs. ..... 1.
5.0 lbs. ..... 2.
5.5 lbs. ..... 3.
6.0 lbs ..... 4.
6.5 lbs ..... 5.
7.0 lbs. ..... 6.
8 lbs. or more ..... 7.

4 What type of processor will you require? *(Choose one.)*

Intel 486 SX/33 MHz ..... 1.
Intel 486 DX2/50 MHz ..... 2.
Cyrix DX2/50 MHz ..... 3.
Cyrix DX2/66 MHz ..... 4.
Cyrix DX2//80 MHz ..... 5.
Intel 486 DX4/75MHz ..... 6.
Intel 486 DX4/100 MHz ..... 7.
486, unsure which version ..... 8.
Intel Pentium 60 MHz ..... 9.
Intel Pentium 75 MHz ..... 10.
Intel Pentium 90 MHz ..... 11.
Intel Pentium 100 MHz ..... 12.
Intel Pentium 120 MHz ..... 13.
Intel Pentium 150 MHz ..... 14.
Intel Pentium, unsure which version ..... 15.
AMD K5 ..... 16.
Cyrix M1 ..... 17.
Other ..... 18.
Don't know ..... 19.

4A What type of bus will you require?

PCI only ..... 1.
ISA only ..... 2.
Both PCI and ISA ..... 3.
No preference ..... 4.

5 Which screen will you require for your portable computer?

Screen type *(Choose one.)*
Monochrome ..... 1.
Dual-scan color ..... 2.
Active-matrix color ..... 3.
Screen size *(Choose one.)*
8.4 diagonal ..... 4.
9.4 inch diagonal ..... 5.
10.4 inch diagonal ..... 6.
11.4 inch diagonal ..... 7.
12.4 inch diagonal ..... 8.
Larger than 12.4 inch diagonal ..... 9.

6 (If you require a color screen) What resolution will you require? *(Choose one.)*

640 x 480 x 256 colors ..... 1.
800 x 600 x 256 colors ..... 2.
1024 x 768 x 256 colors ..... 3.
1280 x 1024 x 256 colors ..... 4.
1024 x 768 true color ..... 5.
Uncertain ..... 6.

7 Will you require the following in your portable, docking station or both?

	Portable	Docking Station	Both	Neither
Speakers	1.	2.	3.	4.
Available CD-ROM	5.	6.	7.	8.
Available floppy drive	9.	10.	11.	12.
Parallel port	13.	14.	15.	16.
Serial port	17.	18.	19.	20.
Ethernet port	21.	22.	23.	24.
Infrared port	25.	26.	27.	28.
SCSI port	29.	30.	31.	32.
Tape back-up	33.	34.	35.	36.

8 (If paid by employer in 1A) Would your organization agree to purchase terms of net 45 days with 3% late fee stipulated? *(Choose one.)*

Yes ..... 1.
No ..... 2.
Uncertain ..... 3.

9 What is the most important feature you look for in a notebook computer?

_____
_____
_____
_____
_____
_____
_____

BYTE

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The contest is open to all U.S. residents 18 years of age or older. No purchase necessary. An individual may enter regardless of whether or not he or she chooses to participate in the survey. Entrants should fill out their daytime telephone number where indicated. Limit: one entry per person.

Entries must be received by July 31, 1995 to be eligible for the drawing. The finalist will be determined in a random drawing to take place at BYTE. The winner will be contacted by telephone on August 1, 1995. Personal contact with the individual specified on the entry card must be made for the finalist to be declared the winner. If the winner cannot be contacted within 15 days of the drawing, then the unclaimed prize will be awarded to an alternate winner selected at random. The winner shall be required to sign an affidavit releasing McGraw-Hill, Inc., from liability in connection with use of the prize.

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City: _____ **State:** _____ **Zip:** _____

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Fax your responses to (603) 924-2535, or mail them to BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.



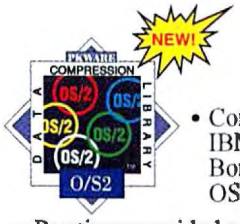
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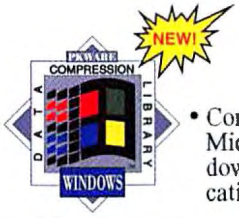
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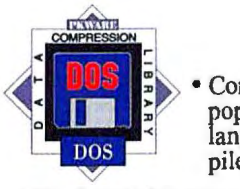
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number of activities per process rises. We were alarmed by a drastic slowdown on one test machine (a Tandy [AST] 486SX/33 with 4 MB of RAM—Scitor's minimum memory requirement) until we realized that our unlimited seed value was shoving articles through the process in gridlock-inducing volumes. You can also get into some trouble by monkeying with a variable that controls the real-time speed of each activity.

The light show pales in value to the copious reports that Process Charter creates post-simulation. As shown in the diagram on this page, the Flow Model and Key Values spreadsheets are usually your best analysis tools. Flow Model tabulates the raw numbers of objects that flowed through the system and the average time spent on each activity. Key Values summarizes the important Flow Model data. Here's where you nail bottlenecks and spot inefficient uses of high-priced personnel.

There's Nothing Like It

Besides the few quibbles already cited, a few more bear mention. The manual, though nicely laid out, methodical, and comprehensive, is missing index entries for such key terms as "seed," and several toolbar items are ignored, though you can find the references by flipping through text. The on-line help is similarly spotty, and the manual-based tutorial is too short. On the other hand, Scitor throws in three simple-yet-informative sample processes as well as some on-line case studies.

Deeper study of simulation is probably necessary to get the full value of the program. Furthermore, accurately depicting business processes in the flowchart takes much thought, while assigning honest numbers to the spreadsheets is a potential pitfall. Still, process modeling and simulation is an undeniably powerful tool, and Process Charter for Windows will likely do more than any previous program to make these disciplines accessible to non-specialists. ■

David Essex is a technical editor for BYTE reviews. He can be reached on the Internet or BIX at dessex@bix.com.

Product Information

Process Charter for Windows 1.0 ..... **$595**
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Wanted: A Good OS/2 Spreadsheet

In the duel between OS/2 spreadsheets, Lotus and Athena Design left some empty chambers in their six shooters

DANIEL GASTEIGER

Despite the recent popularity of IBM's OS/2 and its hipper, leaner offspring, Warp, none of the major spreadsheet developers have taken the technically impressive OS very seriously. Lotus has remained the key provider of OS/2 spreadsheet technology, but its product plays like a DOS version of 1-2-3 barely adapted to OS/2's GUI. And it lags way behind Lotus's other GUI spreadsheet, 1-2-3 for Windows release 5.

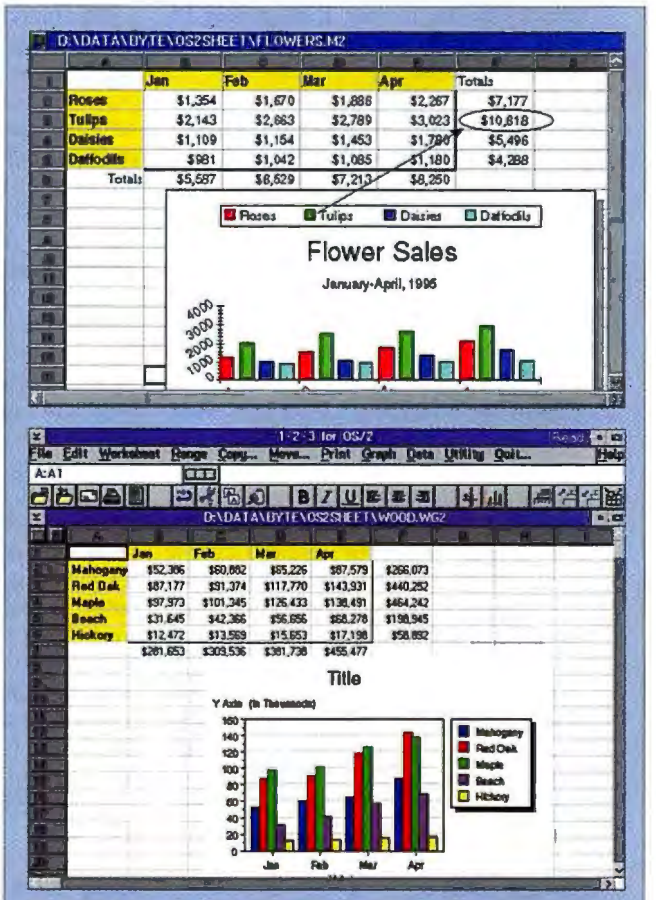
Meanwhile, a lesser known company, Athena Design (Boston, MA) has been running its own spreadsheet software, called Mesa, on Next machines. Late last year, the company began shipping Mesa 2.0.1, a totally new spreadsheet for OS/2 based loosely on the Next version. Mesa offers many advanced features, and its object-oriented approach makes it an excellent fit in the GUI environment.

Unfortunately, it seems as if Mesa's designers skipped history class on the day electronic spreadsheets were covered. Users raised on other platforms (1-2-3 or Novell's Quattro Pro for DOS; 1-2-3, Quattro Pro, or Microsoft Excel for Windows; or 1-2-3 or Excel for the Macintosh) will likely feel frustrated working in Mesa. With so many outstanding examples of the spreadsheet around, it's surprising anyone would ship such a powerful spreadsheet that falls short in so many areas.

GUI Enough for You?

1-2-3 release 2.1 for OS/2 is a full-featured DOS spreadsheet with many graphical goodies sprinkled in. Unfortunately, sprinkling does not a GUI spreadsheet make; 1-2-3 still feels as though it belongs in DOS. Lotus plans to change all this with the expected debut of Windows 95 in August. Lotus says the OS/2 Warp version of 1-2-3 will have some of the advanced GUI features of Windows 95, such as new right-mouse-button controls and a simplified user interface that employs a tabbed book metaphor. Modeless InfoBox widgets will let you change spreadsheet attributes and see the results without first closing dialog boxes. Tighter integration of suite applications is also planned. The goal is to standardize features sets of the Windows and OS/2 versions of 1-2-3.

At the other extreme, Mesa is a GUI spreadsheet from the ground up, but it falls short of being full-featured. At least both products deliver on one feature that has become a spreadsheet standard: three-dimensionality. A 1-2-3 file contains 256 spreadsheet layers, and a Mesa workbook begins with one layer that you can add to as needed. If you're a graphical 3-D spreadsheet product, you really must have index tabs on your sheet layers. Mesa has such tabs, but 1-2-3 does not. Hand in hand with sheet tabs, Mesa gives you the ability to name sheet layers and to use the names in formula references. Nameable tabs simplify navigating in three dimensions and entering formulas that span several sheet layers.



Mesa 2.0.1 (top) and 1-2-3 release 2.1 both let you draw on spreadsheets as well as superimpose graphs and imported files. However, the drawing tools, especially 1-2-3's, are somewhat awkward and limited.

In a poorly conceived departure from a GUI spreadsheet standard, Mesa places its sheet tabs on the right edges of its layers, perhaps to conform to the OS/2 standard of running tabs down the sides of hypertext help pages. The Big Three Windows spreadsheets (1-2-3, Excel, and Quattro Pro) arrange tabs at the top or bottom edges, with the obvious advantage of sacrificing only one of 20 rows on the display rather than one of nine spreadsheet columns. Experienced spreadsheet users may find Mesa's seven-column display constricted.

GUI spreadsheets should also be able to show graphs and drawings alongside numeric data. 1-2-3 lets you paste graphs in the spreadsheet and add graphics from the clipboard or from graphics files. However, to draw on the spreadsheet, you must create an image in some other program and paste it into the sheet—moving and resizing the image until you get the desired result. Mesa's draw layer is slightly more sophisticated. With it you place lines, arrows, circles, and rectangles on the sheet as you might with a simple paint program. These tools could use refinement, though; for example, adding a geometric shape to the worksheet requires interacting with a cryptic dialog box (see the screens above for a comparison of 1-2-3's and Mesa's graphing abilities).

Perhaps the most obvious GUI feature of both 1-2-3 and Mesa is their respective toolbar facilities. In both products, a collection of buttons appears across the top

Wanted: A Good OS/2 Spreadsheet

border of the spreadsheet as one-click shortcuts to common tasks. In 1-2-3, the default icon palette holds 21 SmartIcons, and there is a dialog box you can use to change to other palettes, and even to design your own palettes. You can select from more than 60 icons as you customize the SmartIcons facility. Mesa calls its collection of icons the toolbar. It offers only 15 icons, and there is no utility for customizing the collection.

Mesa gathers a huge number of spreadsheet formatting and editing tools into a package of dialog boxes called the Selection Manager. Using the dialog boxes, you can add sheet layers, assign page names, add rows and columns, change widths of columns and heights of rows, and so on. These options and more are available through Mesa's pull-down menus, so the Selection Manager is a sort of shortcut to oft-needed commands.

Both Mesa and 1-2-3 offer variations on a number of useful GUI features. For example, 1-2-3 lets you view up to five successive spreadsheet layers simultaneously in a "perspective" view, and Mesa lets you open multiple windows onto a single workbook. Both spreadsheets provide copious graphing options—bar, line, pie, area, and *x,y* (scatter plot) graphs, to name a few. While Mesa displays a graph in the spreadsheet, it offers only textual dialog boxes and pull-down menus to help you choose graph types. Once you activate 1-2-3's graph window, you can access a graph gallery in which pictures represent the available graph types. Such a gallery is decidedly GUI-like, and sorely missing in Mesa.

The Rest of the Story

An important feature set for any spreadsheet is a robust collection of navigation aides. Users of DOS spreadsheets have always had powerful cursor-movement options. Mesa's concession to keyboard users is to allow one-page hops via the PageUp and PageDown keys and a jump to cell A1 via the Home key. To make serious jumps around the sheet, you have to use the mouse.

The paucity of keyboard navigation options in Mesa shows up in its cell-editing facility as well. For example, as you create a formula entry, you must either type cell and range addresses, or click and drag over cells and ranges to include in the formula. Moving your hands from keyboard to mouse and back as you build complex @ functions becomes tiresome, particularly if you're used to pressing arrow keys to point at cells and ranges. Gosh, you can't even highlight a range by holding down Shift and pressing arrow keys.

What GUI spreadsheet doesn't offer database management tools? Mesa. 1-2-3, though, contains a sophisticated tool set, including the powerful and underrated (albeit sometimes tricky) DataLens facility for linking to external database tables. With it you can query databases across networks, join tables, and perform virtually any database operation. Even without DataLens, 1-2-3's ability to query databases built in the spreadsheet is quite powerful and gives 1-2-3 a significant edge over Mesa.

SPREADSHEET FEATURES: WHICH PROGRAM IS BETTER?

FEATURE	1-2-3	MESA
GUI	Poor	Good
3-D worksheet files	Good	Good
Nameable sheet tabs	None	Good
Recalculation speed	Fair	Excellent
Use of cursor keys	Excellent	Poor
Charts/graphical objects	Fair	Good
In-sheet database management	Good	None
Access to external databases	Good	None
Shortcut icons on toolbar	Excellent	Fair
OVERALL	Good	Fair

Red indicates winner for that category.

Power User's Powerhouse

Power users are often willing to trade a slick user interface for high-speed, low-resource performance. Depending on your exact needs, Mesa will likely be the better choice. For one thing, there's the size of the two programs. Mesa comes on two floppy disks, and 1-2-3 comes on five (six, according to the documentation, but we found only five). Considering how many more features 1-2-3 offers, it's not surprising that Mesa is so much smaller.

Once you've installed the software, you'll discover further performance differences. For example, launching Mesa from the desktop took nearly 40 seconds if it was our first task after booting up OS/2; launching 1-2-3 took only 19 seconds. On another measure, a Mesa file containing a small (6 columns by 6 rows) spreadsheet model and a single bar chart used less than 7 KB of disk space. A similar 1-2-3 file along with its satellite graph file used over 16 KB. Finally, when we loaded the spreadsheet with formulas that keyed off the @RAND function (a random number generator), a recalculation cycle in 1-2-3 took almost twice as long as it did in Mesa.

People who build automated spreadsheet applications might appreciate Mesa's use of REXX for a macro language. REXX is OS/2's built-in programming language, so it's a natural choice to automate any OS/2 application and to link processes across applications. Mesa also includes some spreadsheet-specific procedures you can call from REXX scripts.

On the other hand, 1-2-3 uses a proprietary programming language to augment simple keystroke macros. This approach makes spreadsheet automation easy to learn, especially given adequate documentation in 1-2-3's manual and on-line help system.

Why 1-2-3 Is Superior

Dozens of other features distinguish the two products, and most of them weigh in favor of 1-2-3. For example, 1-2-3 is keystroke- and macro-compatible with the DOS versions of 1-2-3, so it affords the only reasonable upgrade path for people with spreadsheets already running in DOS. For the time being, the current OS/2 release offers most of what you could want in a spreadsheet; it's just not packaged appropriately for a GUI OS. What's more, it's a better spreadsheet overall than Athena Design's much more graphical Mesa. ■

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Product Information

Lotus 1-2-3 release 2.1 for OS/2 . . . . $495
Lotus Development Corp.
Cambridge, MA
(800) 343-5414
(617) 577-8500
fax: (617) 693-4551
Internet: http://www.lotus.com/
Circle 1001 on Inquiry Card.

Mesa 2.0.1 . . . . . $199
Athena Design, Inc.
Boston, MA
(617) 426-6372
fax: (617) 426-7665
E-mail: info@athena.com
Circle 1002 on Inquiry Card.

Simple SQL

Four Windows tools enable easy data access for business managers

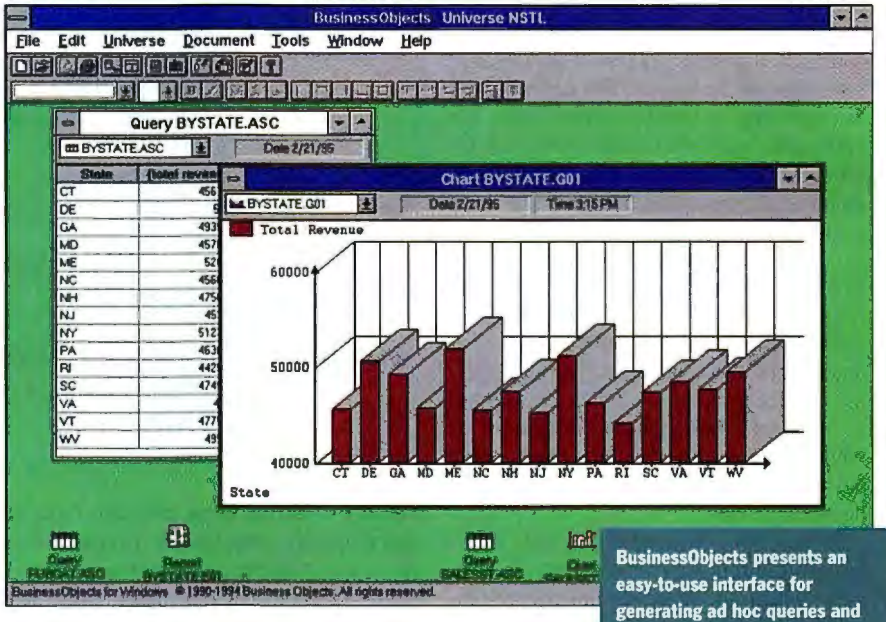
CHARLES VOGT

SQL is a foreign language to most business managers, yet their information demands require on-line access to enterprise databases. These days, you can't rely on scheduled summary reports; to compete, organizations must deliver real-time data to business managers so that they can make informed, time-critical decisions. SQL front-end tools empower nontechnical managers by giving them direct access to client/server databases.

Because the principal task of the products examined in this report is to give nontechnical users easy access to corporate data, they all must support an *administrative layer*. This insulates the manager from the complexities of the database structure and from having to learn SQL.

This report includes evaluations of Andyne GQL from Andyne Computing; BusinessObjects from BusinessObjects, Inc.; Esperant from Software AG; and IQ for Windows from IQ Software. Impromptu from Cognos is not included in this group because a stable prerelease copy of version 3.0 was not available in time (see the text box "Impromptu: The Report-Based Alternative" on page 223 for an early impression).

Version 2.1.1 of Esperant is evaluated in this report, but version 3.0 is scheduled for release by the time you read this. Software AG says the new version will incorporate many new features on top of its core technology. But the focus of this review is not on query/reporting tools that provide some features of the administrative layer (e.g., predefining the joins in the database). Such programs are oriented more toward programmers and technical users and do not fit NSTL's criteria for this report.



BusinessObjects presents an easy-to-use interface for generating ad hoc queries and defining selection and sorting criteria. Once a query is finished, you can easily create reports and charts for presenting the data. Of the four programs reviewed, BusinessObjects delivers the most polished solution.

Querying Paradigms

BusinessObjects and Esperant take similar approaches to organizing data and offer flexible structures for building the query model. Both organize data into categories (referred to as *classes* in BusinessObjects) and items.

Essentially, each category consists of a customized table or view. The names of the categories are defined by the SQL administrator. Items (referred to as *objects* in BusinessObjects) correspond directly to the columns in a database, although the administrator has the ability to create calculated columns.

Both packages permit columns from more than one table to be represented as a single category in the query model. Because the products also support multiple models, the administrator can tailor the data to match the perspective of a specific department or manager.

IQ for Windows organizes a database into so-called IQ Views for querying. The administrator determines which tables to include. All the columns in the IQ View are then presented to the end user as a list;

OVERVIEW

NSTL RATING		VERSION	PERFORMANCE	VERSATILITY	EASE OF USE	EASE OF LEARNING	PRICE
★★★	BusinessObjects	3.1	▲	▲	▲	▲	$595*
★★★	Esperant	2.1.1	■	■	▲	▲	$595
★★★	Andyne GQL	3.3	▲	■	▲	▲	$495*
★★	IQ for Windows	4.0	▼	■	■	■	$500*

*Prices are for end-user kits only. To get full use of programs, Andyne GQL, BusinessObjects, and IQ for Windows require separate administrator modules, priced at $1995, $3495, and $950, respectively.

KEY

★★★★★	Outstanding
★★★★	Excellent
★★★	Average
★★	Below average
★	Poor
▲	Good
■	Fair
▼	Unacceptable

this does away with the entire concept of tables and categories. The administrator can create many IQ Views that show different subsets of columns, depending on the context being served (but only one IQ View can be used at a time). IQ is the only product here that does not permit permanent definition of calculated columns.

Andyne GQL takes a much different approach. It graphically represents tables in a window on the screen. The tables appear as icons that resemble folders. Once the tables are organized on the screen, the administrator defines the joins by making physical connections between the table icons. Tables that define the intersection of two tables appear as a link between two tables (which is referred to as an *embedded relationship*).

Even though it depends on physical links to define a model, Andyne GQL permits tables to be merged and represented as one view. This is limited to instances where there is a one-to-many relationship between the table being merged and the destination view.

In addition, Andyne GQL adds flexibility by letting you define multiple windows within the same administrative layer. This lets you represent the database, or different parts of it, on separate screens. You can also define procedures to automate certain tasks and to add buttons to the windows that automatically run predefined queries.

SQL Joins

All four SQL tools support direct joins between tables. With all the programs except for Esperant, the administrator defines joins from a dialog box that constructs the join statements (e.g., `orders.ordernum = entry.ordernum`) and creates a new table of defined joins. Rather than defining the join clauses, the Esperant administrator defines the primary and, if applicable, foreign key(s) for each table and then indicates whether the relationship is one-to-one, one-to-many optional, or one-to-many required.

The definition of joins gets more complicated if an administrator defines multiple join paths in the model. If the SQL tool being used does not provide a facility for resolving the ambiguity, a query will generate a Cartesian product, listing each record with all possible join combinations. Depending on the number of rows involved, this process could tie up the server for a long time.

BusinessObjects and Esperant resolve ambiguous joins by permitting the administrator to define what they call *contexts* and *join paths*, respectively. In cases where there are multiple paths between the columns selected for the query, these two tools prompt the user to select one of the defined paths between the tables.

In Andyne GQL, the user graphically identifies the path to be taken between the tables during the definition of the query. However, GQL does not provide any facility for preventing the user from selecting both paths between the tables. If both paths are chosen, GQL generates a Cartesian product of the tables included in the query.

IQ for Windows is the only tool that does not provide a facility for resolving ambiguous join paths. If an IQ View is created that refers to tables with multiple join paths, an IQ query will generate a Cartesian product. The only available solution in IQ is to create separate IQ Views, each defining only one of the paths between the tables.

Query Capabilities

All four products let you build calculated fields (e.g., revenue) along with aggregate fields (e.g., total revenue from all sales or total number of sales). In addition, all four can generate aggregates for groups (e.g., total sales or total volume of sales by product category).

IQ for Windows, however, performs all the calculations itself instead of using the aggregate functions in SQL. IQ achieves most of the same functionality as the other products by retrieving all the detail records that match the query criteria and then performing the calculations on the system that's running IQ. (The effect of this is evident in some of the performance results.) IQ lacks one important capability in this area: It can't apply the SQL COUNT statement to a joined table (e.g., the orders table in a query retrieving orders by salesperson).

Esperant offers different query capabilities by extending the kinds of information that can be generated in an ad hoc manner. These extensions include complex subqueries that you can apply as criteria in record selection, queries that return the percentage of items matching the specified criteria, queries that compare two sets of records, and queries that calculate the result as a percentage of the aggregate (e.g., total, average, maximum, and minimum).

Esperant's Query Expert is a rules-based interface designed for nontechnical and technical users alike. It uniquely incorporates rules to ensure that you produce only valid and semantically correct queries. It's the only interface that prevents you from generating invalid queries that include aggregates by graying-out invalid selections based on the choices made.

As a result, Query Expert prevents you from improperly using aggregates at multiple levels of detail. You can easily make this kind of mistake in BusinessObjects and Andyne GQL; the result of such a mistake is a syntactically correct SQL SE-

Highlights

	Strengths	Limitations
Andyne GQL	Can display database structures graphically Automated query buttons Easy importing of database structures	Graphical model limits flexibility, adds to maintenance Limited to one query at a time Overly technical user's manual
BusinessObjects	Fastest program overall Easiest interface for creating queries Best facilities for distributing administrator layer	Administrator must maintain macro objects Report editor is difficult to use Query names limited to eight characters
Esperant	Query Expert helps avoid semantic mistakes Easiest report generation and editing Most flexible security	Administrative layer is difficult to create and maintain Limited to one query at a time Slower querying of large databases
IQ for Windows	Cross-tab queries are easy to generate Charts are easy to generate Flexible report writer	Report writer is difficult to learn Slower queries with aggregates Cannot permanently define calculated columns

Testing by the Book

NSTL tested the speed of the four SQL query tools using a book-order-entry database. Tests were done on Microsoft SQL Server for NT 4.2 running on top of Windows NT Server 3.5, which acted as a back-end server. The SQL query tools ran on a separate workstation under Windows for Workgroups 3.11.

The test database consists of eight tables: books, categories, publishers, authors, links, orders, entries, and salespeople. The amount of data in the database is purposely kept to a minimum so that the tests measure the speed of the query tool, not of the database server.

The database consists of 2048 books, 20 categories of books, 30 publishers, and 256 authors. Each book has two authors, as is indicated in the 4096 link records. The database was created with 4096 order records, a total of 20,480 entry records (five books are sold per order), and 15 salespeople.

The *simple select* test measures the time required to run a simple query that retrieves the first and last names sorted by last name, then first name, from the author table (which has 256 rows). The database server takes little time to process this query and return the data.

FRONT-END PERFORMANCE
All times are in seconds.

	ANDYNE GQL	BUSINESSOBJECTS	ESPERANT	IQ FOR WINDOWS
Simple select	1.6	1.5	8.8	3.7
Query with three-table join	5.6	4.7	27.8	7.1
Query with grouping and subtotal	8.4	7.9	28.4	308.2
Complex query with report to screen	22.2	21.9	31.6	42.3
Print report: Return of control	24.7	10.6	9.7	219.9
Print report: Page drop	162.1	139.6	140.0	355.1

Although all four products generate equivalent queries that take the same amount of time for the server to process, IQ for Windows and Esperant take substantially longer to process the query. NSTL attributes the slow performance of both to inefficiency in storing the data in their local data structures (in RAM).

Query with three-table join measures the time required to run a more complex query that retrieves the names of authors and book titles by authors with last names that start with *H* or *S*. The query specification includes sorting the records first by the author's last name and then by first name. This query requires data from three tables (authors, links, and books) and returns 584 rows from the database. The database server takes somewhat longer to process this query than the first because it must join the three tables and retrieve data from both authors and titles.

Query with grouping and subtotal measures the speed of processing a more complex query that groups the resulting records and calculates a subtotal. Each program creates a query that retrieves the total revenue generated by each salesperson by state.

The results of this test show a surprising spread in performance. The database server takes significantly longer to process this query than it does for the first two tests. Correspondingly, Esperant's performance is better on this test, because the time for the server to process the query represents a greater portion of the total time.

Andyne GQL, BusinessObjects, and Esperant all generate essentially identical queries by making use of the SQL SUM and GROUP BY clauses. As a result, the database server does all the calculations and returns 15 rows (one for each state), grouped by salesperson.

In contrast to the other programs, IQ for Windows takes a much different approach to this query—and all queries that include aggregates. Instead of using the GROUP BY and aggregate functions to have the server perform such calculations, IQ retrieves all the detail records that correspond to the selection criteria. In this case, it retrieves 20,480 entry records and 4096 order records, along with the first and last names of the 30 salespeople. After retrieving the detail records, IQ sorts the records and calculates the subtotals by state on the local computer.

Complex query with report to screen measures how long it takes to process a complex query (with results grouped by two criteria) and to generate a screen report with two levels of subtotals and a grand total. This test measures the speed at which the query tools can process aggregates on grouped result records, as well as the speed at which the results of a query can be presented as a report. (The result shown in the table for BusinessObjects includes the time the program took to execute the query as well as the time it needed to generate the report as a separate step in the process.)

This test measured the speed of Esperant's Reporter rather than that of its Query System. The Reporter automatically runs the query and generates the report without the intermediate step of displaying the results in a columnar matrix. Also, because this test includes an aggregate (i.e., total sales revenue for each category by state), IQ for Windows again retrieves all the detail and order records (1801 and 1522, respectively) and calculates the aggregate locally.

In the *print report* test, technicians print the 15-page report generated during the previous test to a Texas Instruments microLaser with the Windows Print Manager enabled. Testers format the reports in each program as identically as possible (with regard to such details as fonts, borders, headings, and titles) for this and the previous test.

For this test, NSTL records two times for each program: the time elapsed until control is returned to the user, and the time for the completion of the printing (determined by the drop of the last page from the printer). Because this test measures the time needed to print a report already generated to screen, the times for return of control to the user are short.

The exception to this, however, is IQ for Windows, which takes more than 20 times as long as Esperant to return control. IQ does not permit a report generated to screen to be printed. Instead, the user must close the report and select Output to Printer to print the report. IQ then, again, processes the query before generating the printed output.

QUERY FEATURES

	ANDYNE GQL	BUSINESSOBJECTS	ESPERANT	IQ FOR WINDOWS
Administrative				
Automatic dictionary/model generation	●	●	●	●
Redefine column/table names	●	●	●	●
Add descriptions for column/table names	○	○	●	○
Show columns from multiple tables in a single entity	●	●	●	●
Define calculated columns in model	●	●	●	○
Redefine display format for column	●	○	○	●
Define valid joins	●	●	●	●
Define multiple joins between tables	●	●	●	●
Define theta joins using complex criteria	●	●	●	●
Define complex join paths (ambiguous joins)	●	●	●	○
Limit tables displayed/accessible	●	●	●	●
Limit columns displayed/accessible	●	●	●	●
Limit number of rows returned	○	●	●	●
Distribute models via database	●	●	○	○
Automate queries as graphical buttons	●	○	○	[1]
Define dialog boxes for user-query entry	●	●	○	○
Set up user accounts for queries only	○	●	●	●
Define groups of users	○	○	●	●
End-User Facilities				
Multiple active query/result windows	●	●	○	○
Start multiple instances of program	●	●	○	○
Save query for personal/global use	●	●	●	●
Guards against semantically incorrect queries	○	○	●	●
Permits direct entry of SQL	[2]	○	●	○
User can limit number of rows retrieved	○	●	○	●
User can cancel queries	●	●	●	●
Query Criteria				
Insert criteria from static lists	●	●	○	○
Apply criteria to calculated values	●	●	●	●
Supports union operator	○	○	●	○
Can store lists of selection criteria	●	●	○	○
Supports outer joins (with database server)	●	○	●	●
Automatically generates subqueries based on criteria	○	○	●	○
Replace retrieved values with defined text/values	●	○	○	○
Save SQL code generated by query	●	●	●	○
Query Calculations				
Count records matching criteria	●	●	●	●
Count records in joined table	●	●	●	○
Show percentage that matches criteria	○	○	●	○
Compare two sets of results	○	○	●	○
Add calculated column using arithmetic functions	●	●	●	●
Add calculated column using trigonometric, other functions	●	●	●	○
Query Results				
Filter/sort results without resubmitting query	●	○	○	○
Dynamically adjust column widths	●	●	●	○
Change order of columns	●	○	○	○
Add calculated fields without resubmitting query	○	○	○	○

● = yes
○ = no

[1] Queries can be saved as icons in Program Manager.
[2] Instead lets you send SQL scripts from text files.

LECT statement that produces results of indeterminate meaning (for more details, see the review "Make Bulletproof SQL Queries," February BYTE).

GQL is the only tool that has a drill-down feature in its query interface. After retrieving the results of a query, you can use GQL's drill-down mode to highlight a result in the retrieved data. Once a result is highlighted, it's automatically added as a selection criterion for retrieving more detailed information. This feature lets you move quickly from a summary to detailed information.

Performance Considerations

NSTL's tests reveal some significant performance differences among the four products, even on simple queries (see the text box "Testing by the Book" on page 219). BusinessObjects and Andyne GQL perform up to expectations. But Esperant is surprisingly slow when storing information retrieved (in RAM) from the database server.

It takes Esperant significantly longer than BusinessObjects and GQL to retrieve even simple queries. Esperant's poor performance is less noticeable on queries that take longer to process on the server, because Esperant adds time only after it starts receiving the enterprise data.

Unlike Esperant, IQ for Windows' slow performance is directly attributable to the way it uses SQL. IQ does not use the aggregate functions in SQL to generate summary information. Instead, it retrieves all the corresponding detail records and then performs the calculation locally. This has two effects: More of the network bandwidth is used between the database server and the client generating the query, and the queries using aggregates tend to take substantially longer to run than they would if processed on the server.

Model Distribution

The facilities that are provided for distribution and security vary significantly among these products. BusinessObjects provides the cleanest approach by using a database, or databases, to store and distribute *universes*. Prior to installation, BusinessObjects creates a repository database on a server that's accessible to all users. (Multiple repositories on various servers can be created later if all users cannot access a single database server.)

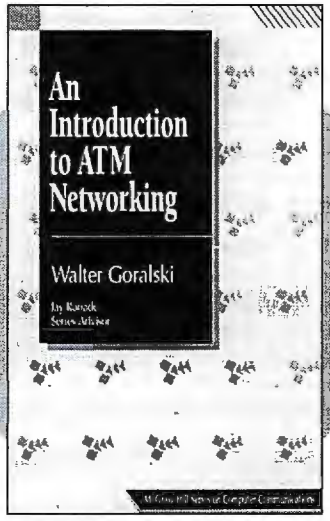
Thus, when the administrator completes the definition or maintenance of a universe, the universe is exported to the repository; a user's copy of the universe is then

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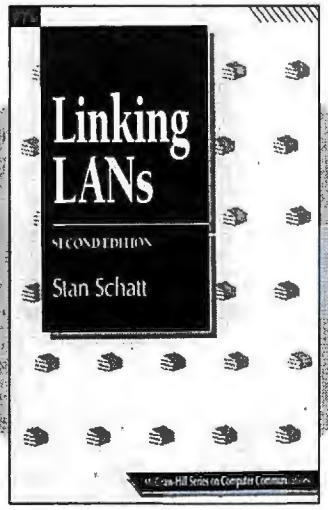
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0-07-042724-0 / $60.00



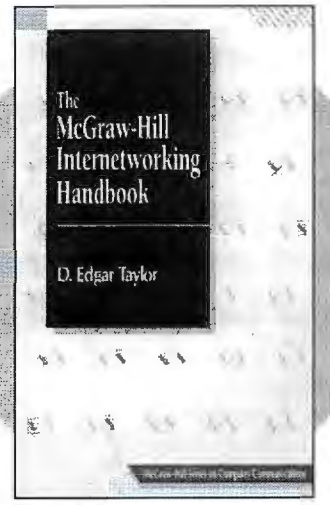
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REPORTING FEATURES

	ANDYNE GQL	BUSINESSOBJECTS	ESPERANT	IQ FOR WINDOWS
General Reporting Facilities				
Automatically generate report from query results	●	●	●	●
Multiple reports can be open for editing	●	○	●	○
Build report from multiple queries	●	○	●	○
Create cross-tab report	○	●	●	●
Create report with multiple rows per result record	●	●	●	●
Can group results	●	●	●	●
Collapse/expand level of detail displayed	○	●	○	○
Report on stored results	●	●	●	○
Generate partial report	○	●	○	○
Create report templates	●	●	○	○
Define headers, footers for breaks	○	●	●	●
Supports subtotals, grand totals	●	●	●	●
Formatting and Editing (Overall Report)				
Select typeface/size	●	●	●	●
User-defined field widths	●	●	●	●
User-defined field heights	○	●	●	○
Horizontally align contents	○	●	●	●
Vertically align contents	○	●	○	○
Word-wrap within fields	●	●	●	●
Add title page	●	○	●	○
Editing toolbars and ruler	○	●	●	●
Snap to grid (helps align contents)	○	○	●	●
Print preview	○	●	●	○
Page Formatting				
Borders, rules	●	●	●	●
User-defined headers, footers	●	●	●	●
Set defined page breaks	●	●	●	●
Include report date/time	●	●	●	●
Include query date/time	○	●	○	○
Set space between rows	○	●	●	●
Hide sections	○	●	●	○
Include linked external objects via DDE	○	●	●	○
Charting				
Bar (columns)	○	●	○	●
Pie	○	●	○	●
Line	○	●	○	●
Scatter	○	●	○	●
Area	○	●	○	●
Combination (e.g., line, histogram)	○	○	○	○
Include legend	○	●	○	●
Data Exporting				
Can act as Windows DDE server	●	●	○	○
dBase	○	●	○	●
Paradox	○	○	○	○
Excel	●	●	●	●
1-2-3 for Windows	●	○	○	○
1-2-3 for DOS or Unix	○	●	●	●
Quattro Pro	○	○	●	○
ASCII delimited text	●	●	●	●
Microsoft Word for Windows	●	○	○	●
Microsoft Word for DOS	○	●	○	○
WordPerfect	○	●	○	●
API for external access to query function	○	○	●	○

● = yes; ○ = no.

automatically updated the next time he or she uses it. The same mechanism is used to distribute queries defined by the administrator (or by anyone else). With this mechanism, a user automatically has a personal copy of the universe definition with his or her defined queries, which allows the administrator to easily update the base definition of the universe.

Andyne GQL models are distributed by making the model file(s) freely accessible. They can be either copied locally or shared. If the files are copied locally, updates can then be distributed automatically by the database. GQL can update the administrative layer separately from the user layer, so changes can be made to the database structure without affecting any customizations.

The administrator distributes Esperant's so-called DataViews by either copying the files onto the local disk or granting read access to a shared directory. Any updates are made globally by updating the shared directory or, for nonnetworked distribution, by copying the DataView files into each local directory.

The definitions of IQ for Windows' data dictionaries are stored in a single file that the administrator can create and name (with a .DAT extension). Multiple data dictionaries can also be created. The administrator grants access by making the dictionary file available on the network.

SQL Security

All four programs provide some level of security. All except Andyne GQL permit definition of user accounts to control access to the query models.

GQL lets the administrator define a single password per model to restrict user access. In addition to any password required, GQL requires each user to enter the database user ID and password to access the database. A variety of security options are defined when a GQL model is created. The administrator can specify, among other options, whether a user can update the data model, edit the SQL statements generated, and save passwords with defined queries.

Esperant offers a wide range of group-level security. In addition to requiring a user name and password, Esperant requires each user to enter the database user name and password before opening a DataView. (Esperant can also be configured to save queries with the database user ID and password embedded.)

An Esperant administrator can control whether groups of users can open queries,

Impromptu: The Report-Based Alternative

Impromptu 3.0 delivers a different perspective on ad hoc access to databases than the four products tested for this report. Impromptu 3.0, which NSTL evaluated in the early beta stage, takes a report-based approach to ad hoc database access rather than a query-based one. Even with this different perspective, Impromptu has much of the same core functionality as the other products.

With Impromptu, an administrator sets up a *catalog* that creates a layer between the user interface and the underlying database structure. Although the program is report-based, Impromptu's query-definition tool can generate many of the same queries as the other programs. The Impromptu catalog organizes the database's columns into a set of hierarchical folders (much like the categories in Esperant and the classes in BusinessObjects).

Catalog definition in Impromptu starts out with one folder per table in the database, which is based on data retrieved from the data dictionary. Impromptu then lets you move columns from one table to another or move the folder representing a table and insert it one level below another table. An administrator can also define aliases for column and table names and define joins in the database.

You generate Impromptu reports with the query-definition tool, selecting columns and applying selection criteria. Like the four evaluated programs, Impromptu lets you calculate columns, sort data, eliminate repeated data items in grouped queries, and perform aggregate calculations on grouped data. Impromptu even lets you select criteria based on aggregates—a feature provided by Esperant, but not the other three programs.

Many of Impromptu's reporting capabilities are centered around the templates provided with the program. The Impromptu beta version included templates for a catalog list, a customer form, an invoice form, name tags, and mailing labels. The more complex ReportWise templates step you through defining a custom report. Impromptu frames hold the retrieved data, but they can also contain OLE objects, pictures, and text.

Overall, Impromptu offers an alternative perspective on ad hoc data retrieval. NSTL's beta evaluation of Impromptu leads us to believe that Impromptu is worth a close look, especially for organizations interested in generating highly formatted reports from a database.

databases, reports, and saved tables. The administrator can also specify whether a particular user can save query results, save queries, save the generated SQL, and print from the program, among other options.

Each BusinessObjects account can be assigned either novice or expert status, which determines only whether a user can edit the SQL statements generated by the software (experts are permitted to; novices are not). By default, the software automatically connects to the database by using the user ID and password that were stored when the universe was defined.

If an organization requires an individual password, the user ID and password must be added as arguments to the command line that launches BusinessObjects. There is no way to configure BusinessObjects to require each user to enter the database user ID and password in a dialog box.

IQ for Windows provides a broad set of security features based on user accounts and groups of users. However, it implements the security through the DOS character-mode program, and the security is based on assigning numeric levels to users, groups, and various database resources. This makes overseeing the security quite burdensome for the administrator.

Nontechnical SQL

Of the four SQL tools, BusinessObjects delivers the most polished solution. Its paradigm of classes and objects lets the administrator easily establish customized views into critical business data. Distribution of the model through a repository on a database server makes it easy to keep large numbers of users up to date. Once the administrator builds the model and defined macro objects (e.g., calculated fields), BusinessObjects presents an easy-to-use interface for generating ad hoc queries and defining selection and sorting criteria. Once a query finishes, it's easy to create reports and charts for presentation of the data.

Esperant 2.1.1 is a first-generation product that will soon be replaced by version 3.0. While the administrative module of Esperant 2.1.1 is rough around the edges, it does enable an administrator to organize the contents of a database to match specific needs. The key features of Esperant are its query language and Query Expert, which directs you through sophisticated queries with assurance that you're getting all the information you need. Esperant-generated queries take the best advantage of SQL to expand the variety of queries available to business managers for ad hoc information. ■

Where to Find

Andyne Computing, Ltd.
Kingston, Ontario, Canada
(800) 267-0665
(613) 548-4355
Circle 1138 on Inquiry Card.

BusinessObjects, Inc.
Cupertino, CA
(800) 703-1515
(408) 973-9300
Circle 1139 on Inquiry Card.

IQ Software Corp.
Norcross, GA
(800) 458-0386
(404) 446-8880
Circle 1140 on Inquiry Card.

Software AG of North America, Inc.
Reston, VA
(800) 423-2227
(703) 860-5050
Circle 1141 on Inquiry Card.

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32 V.34 MODEMS ANSWER THE CALL

What do you want from a modem? Speed? Interoperability? Reliability? Read on—all the information on 28.8-Kbps external and PC Card modems is right here.

JIM KANE AND HELEN HOLZBAUR

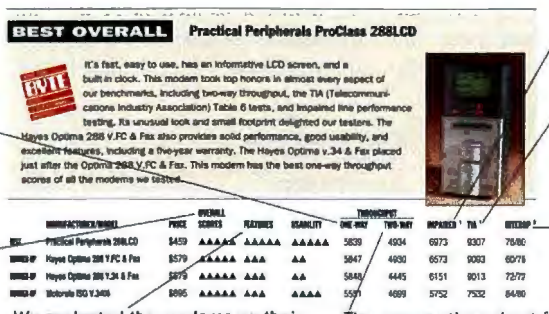
Do you believe that time is money? This old adage is especially true in the world of telecommunications. Every time you access a remote computer, you're incurring costs: the easy-to-spot direct costs, like phone bills and connect charges, as well as the hidden costs of computer time and operator inactivity. It's no wonder we welcome devices that promise to reduce file transfer time. These V.34 modems answer that call.

We tested 25 external and seven PCMCIA PC Card modems, all capable of pushing data at rates of up to 28.8 Kbps. How do these modems transfer data so quickly? To begin with, they use state changes (0 as a low-frequency signal on the wire, 1 as a high signal) to represent data. For modems from the computer Stone Age (i.e., below 1200 baud), the baud rate represented the bit, or transfer, rate. Engineers then discovered that they could encode more than 1 data bit in each state by using DPSK (Differential Phase Shift Keying). Thus, by increasing the number of phase shifts for each bit, a 2400-baud modem could achieve transfer rates of 2400 or 4800 bps.

The next major development, QAM (Quadrature Amplitude Modulation), added a new dimension called amplitude modulation. QAM generates 4 bits for each phase shift, using both phase and amplitude as

How to use this guide

Unless otherwise indicated, performance scores are reported in bytes per second. We weight unidirectional throughput more heavily than the other performance tests, because this test line represents typical line conditions found in most of the U.S. If you have special requirements, such as full-duplex operation or network management, look more closely at the reported "Two-way Communications" result.



The average throughput for each modem during one-way (half-duplex) communication. This represents the typical rate at which the modem transmits data over a normal phone line.

The Overall Score is heavily weighted on performance, but it also takes into account the features, such as spoofing capability, leased-line support (for dedicated high-speed connection to a remote site), and various supported protocols. We also factored usability into the overall score, although lightly, because most people install their modem only once, program the modem software to handle the AT commands, and expect the device to function consistently thereafter.

We evaluated the modems on their features, such as their ability to spoof, the protocols they support, and the availability of on-line help.

Impaired lines simulate difficult phone conditions, including noise and satellite delay.

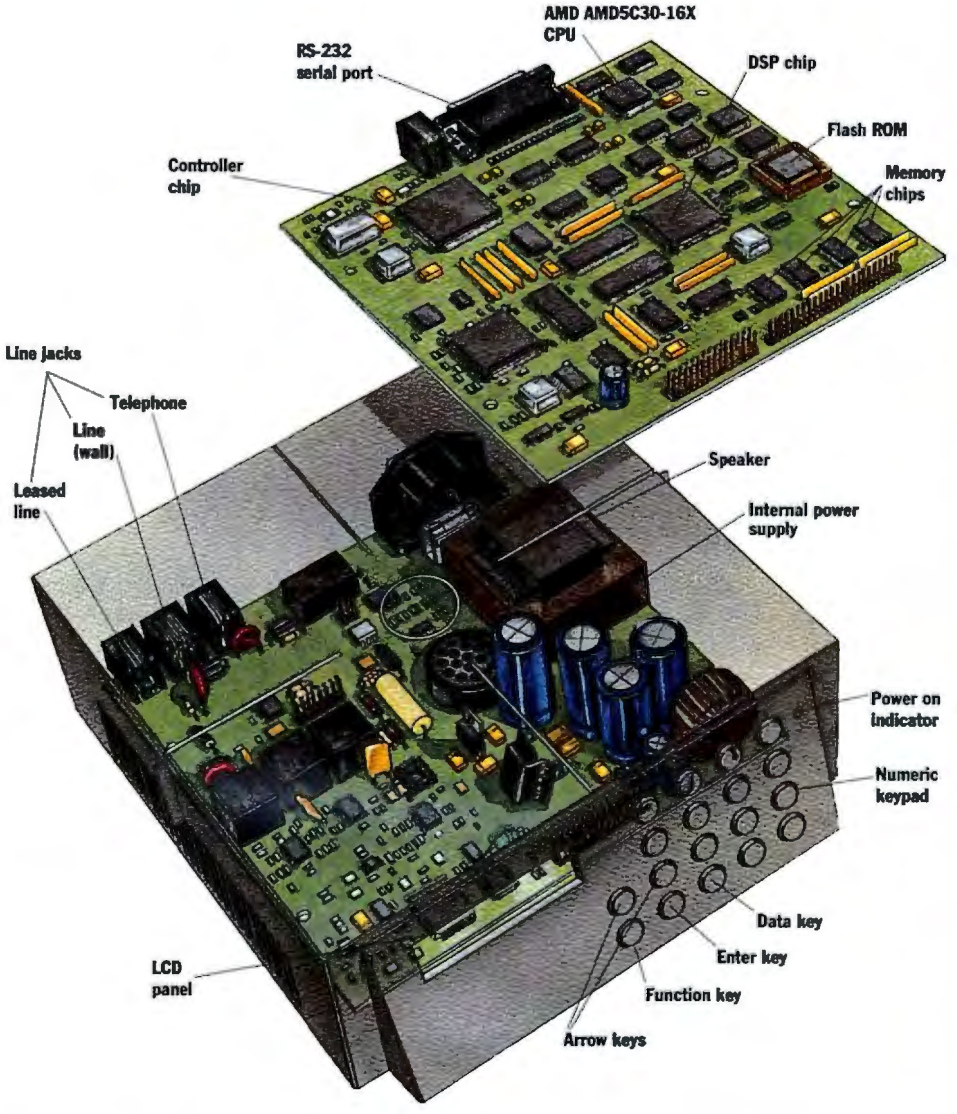
The average performance of a modem over the lines represented by Table 6 of the TIA/EIA Telecommunications System Bulletin TSB37.

The percentage of calls to and from other modems in which a modem made a V.34 connection.

The average throughput for each modem during two-way communication. This score is more important than one-way throughput only for applications that require full-duplex capability, such as LAN bridging.

PHOTOGRAPHY: STEVE BELKOWITZ © 1995

Inside Communications



BYTE BEST

EXTERNALS

BEST OVERALL
Practical Peripherals ProClass 288LCD
This modem is fast, easy to use, has an informative LCD screen, and a built-in clock. It took top honors in almost every aspect of our benchmarks.
PAGE 227

BEST DATA
Practical Peripherals ProClass 288LCD
Impressive performance numbers make the ProClass a winner in the data transfer category. However, it lacks support for flash-ROM upgrades.
PAGE 227

LOW COST
Maxtech/GVC XM288E
The $199 Maxtech modem turned in solid performance numbers and excels in usability. PAGE 227

PC CARD

BEST OVERALL
Practical Peripherals PCMCIA ProClass 288 with EZ-Port
This PC Card modem finished with slightly lower performance numbers than those of the Hayes Optima but posted higher usability numbers. It also tied for top honors on our PCMCIA interoperability testing.
PAGE 231

BEST DATA
Hayes Optima 288 V.34 & Fax
The Optima is the big winner based solely on data throughput. It has the best one-way throughput results of all the PC Card modems we tested. The Hayes also handled the TIA (Telecommunications Industry Association) testing better than the others.
PAGE 231

dimensions. Add in data compression with error correction and modems could accurately transfer large amounts of data (a modem that uses data compression must have an error-correction protocol for it to work).

Microcom developed MNP-5, one of the first data-compression methods. MNP-5 worked with the MNP-4 error-correction protocol to achieve a 2-to-1 yield; a compressible file could be transmitted in half the normal time.

To further things along, the ITU (International Telecommunications Union) came up with the V.42bis compression method. This protocol works with V.42 error correction to provide up to 4-to-1 compression.

The newest class of modems is based on the ITU V.34 standard and pushes the U.S. telephone infrastructure to its limit. V.34 modems differ from their predecessors because they negotiate more than just the basic baud rate, encoding scheme, error-correction, and compression protocols. They also "probe" the line and assess its capabilities and quality to optimize the data transfer rate, and they make necessary adjustments as line conditions change during a transfer. The V.34 standard offers 60 combinations of modulation schemes and baud rates to make line adjustments on the fly.

V.34 sounds great, but you won't see it in action all the time unless you communicate solely within a pristine fiber-optic telephone network system. Even though large cities have installed fiber-optic cable to the telephone trunks, most connections extend through the copper wire strung between poles along the U.S.'s roadways. These links are subject to data disasters caused by electrical interference, rotting insulation, a variety of wildlife, and aging copper wire. Luckily, your V.34 modem falls back to a lower data transfer rate as line conditions worsen. If the line conditions improve, the modems will fall forward again.

ILLUSTRATION: BRUCE SANDERS © 1995

THE FASTEST, THE SLICKEST, AND THE FRIENDLIEST

EXTERNAL V.34 MODEMS

With the advent of the ITU's V.34 specification, the standard Windows 3.1 serial-port communications driver becomes hopelessly outmoded. The Windows driver supports a maximum DTE (data terminal equipment)—your PC—rate of 57,600 bps, and even that is unreliable if you are using your modem in a background application. To overcome this limitation, we tested the modems with Bio-Engineering Research Lab's (Ashland, OR) TurboComm, which is an enhanced serial-port driver for Windows. As a result, we achieved 115,200-bps communication between the modems and the computers, enabling us to test the modems' capabilities rather than Windows' inabilities.

External modems come in all shapes and sizes: We tested the standard rectangles, Sony Watchman look-alikes, and modems that look like baby monitors and even shark fins. The winner of this BYTE/NSTL Lab Report is Practical Peripherals' ProClass 288LCD (it looks like a Sony Watchman).



The Logicode Quicktel exemplifies the new shapes of external modems.

The 288LCD outperformed all the other modems in our impaired tests, in the TIA (Telecommunications Industry Association) lines test, and in the two-way throughput tests. Its features score was high due in large part to the LCD. With a glance at the panel, you can monitor each call's progress, including line conditions, connect speed, and compression type. Attaching cables to it is a little difficult, so if you move your modem around much, the 288LCD may not be your best choice.

The performance of Hayes' Optima V.FC & Fax was almost identical to that of the ProClass 288LCD in the throughput tests. The Optima is a solid performer in all aspects of testing; it has everything we have come to expect from Hayes, including a long features list and the standard Hayes front panel. Surprisingly, its performance result was only average in our Interoperability test, although to many people, a Hayes modem still represents the industry standard.

What really differentiated the top two modems was their ability to transfer files over less-than-ideal line conditions. Here, the edge went to the Practical Peripherals' ProClass 288LCD.

Number three and four were fairly expensive entries: Black Box's Modem 3400 and Motorola ISG's V.3400. These two are steady performers in both ideal and poor line conditions (the Black Box failed only one TIA line, and the Motorola

VOICE AND DATA: CAN THEY SHARE THE SAME LINE?

Wouldn't it be nice to discuss a fax as it is being transmitted or to talk about the contents of a shared whiteboard as it is being altered—all without needing a second telephone line?

Several single-line SVD (Simultaneous Voice and Data) technologies are contending to become the SVD standard (see "Doing It All on One Line," January BYTE). Technologies such as VoiceView from Radish Communications Systems, quickly switch between voice and data to simulate SVD, and Multi Tech Systems' MSP (Multi Tech Supervisory Protocol) and AT&T Paradyne's VoiceSpan provide simultaneous voice-over-data sessions. Intel and a group of modem makers are backing a technology called Digital SVD that lets users put voice and low-rate video on top of data. These schemes are all stopgap SVD solutions until ISDN digital telephony takes over.

To test this emerging technology, we set up an SVD session with two preproduction MT2834PCS-ISI modems from Multi Tech. Multi Tech's proprietary MSP technology uses a packet-transfer scheme to send voice and data simultaneously. The Multi Tech modem's Talk AnyTime hardware feature lets users talk after a data link is established between the two modems.

During testing, when the remote user picked up the handset, we held a conversation using a Digital Simultaneous Data Link (DSP circuitry converts voice into digital format) while still passing data through the modems. We did not notice any significant drop in data transmission performance during our tests when we activated the voice/data feature.



The Multi Tech MT2834PCS-ISI SVD modem.

Of the differing technologies for SVD, Radish's VoiceView is the most widely installed and uses an alternating or switched voice/data integration standard. When it recognizes incoming data, in effect it mutes the handset and begins data reception. As soon as the line is again free of data, the VoiceView-enabled modem reactivates the handset and resumes the role of passive listener. VoiceView does not support videoconferencing and other applications that depend on continuous data flow, but it is an alternative to expensive ISDN solutions. Microsoft is building VoiceView support into Windows 95, and Radish has licensed VoiceView to Rockwell to build into future-generation modem chips.

As with Multi Tech's MSP, AT&T Paradyne's VoiceSpan achieves SVD by allowing voice and data to share bandwidth. Conversation happens at a normal rate, but when you talk and exchange data, speech quality degrades. Intel-supported Digital SVD splits the modem line into two virtual channels: one transmits voice while the other transmits data or graphics.

passed all the lines). Except for the color of their cases, the two look identical. However, nothing about these two modems impressed us enough to justify their $895 price tags: neither supports spoofing (see "What Does It Really Mean" on page 232) for communicating with older software, and both have extremely short warranty periods.

The Maxtech/GVC modem, the XM288E, is our recommendation for those on a tight budget. Both it and the Motorola ISG V.3400 have similar scores for throughput and impaired-line (including the all-encompassing TIA lines) performance, but the XM288E sends faxes faster. As with its more expensive counterparts, the XM288E doesn't support spoofing or flash-ROM upgrades, but it lists for only $199, so you are, in fact, getting what you pay for. All the prices we quote, unless noted, are list prices; you should be able to find lower street prices.



The Hayes Accura v.34 and the U.S. Robotics Sportster V.34 288 are also eligible for the low-cost category. The Accura is a scaled-down version of the more feature-laden Optima, but its performance is just as fast. Surprisingly, U.S. Robotics' Sportster outperformed its higher-end Courier cousin.



Only one modem consistently failed a performance suite: The Archtek SmartLink 2834A simply could not connect to any of the fax machines in our test bed. Even with a firmware upgrade, the modem still could not speak "fax."

KEY

Ratings from 1 to 5: ▲ is the lowest; ▲▲▲▲▲ is the highest.

Practical Peripherals wins hands down

BEST OVERALL — Practical Peripherals ProClass 288LCD



It's fast and easy to use. It has an informative LCD screen and a built-in clock. This modem took top honors in almost every aspect of our benchmarks, including two-way throughput, the TIA (Telecommunications Industry Association) Table 6 tests, and impaired-line performance testing. Its unusual look and small footprint delighted our testers. The Hayes Optima 288 V.FC & Fax also provides solid performance, good usability, and excellent features, including a five-year warranty. The Hayes Optima V.34 & Fax placed just after the Optima 288 V.FC & Fax. This modem has the best one-way throughput scores of all the modems we tested.



	MANUFACTURER/MODEL	PRICE	OVERALL SCORES	FEATURES	USABILITY	THROUGHPUT [1] ONE-WAY	THROUGHPUT [1] TWO-WAY	IMPAIRED [1]	TIA [1]	INTEROP [2]
BEST	Practical Peripherals ProClass 288LCD	$459	▲▲▲▲▲	▲▲▲▲▲	▲▲▲▲▲	5839	4934	6973	9307	76/80
RUNNER-UP	Hayes Optima 288 V.FC & Fax	$579	▲▲▲▲▲	▲▲▲	▲▲	5847	4930	6573	9093	60/76
RUNNER-UP	Hayes Optima 288 V.34 & Fax	$579	▲▲▲▲▲	▲▲▲	▲▲	5848	4445	6151	9013	72/72
RUNNER-UP	Motorola ISG V.3400	$895	▲▲▲▲▲	▲▲▲	▲▲▲▲	5551	4699	5752	7532	84/80

Data throughput, plain and simple

BEST DATA — Practical Peripherals ProClass 288LCD



The criterion for best data modem is speed, speed, and more speed. No fax scores. The 288LCD's impressive performance numbers make it a winner. The LCD serves as a way of programming the modem. This eliminates much of the need to learn complex setup strings, and it lets you configure the modem without being attached to a PC. Unfortunately, the 288LCD lacks support for flash-ROM upgrades. The Hayes Optima V.FC & Fax followed the 288LCD, outperforming it only on one-way throughput.

	MANUFACTURER/MODEL	PRICE	OVERALL SCORES	FEATURES	USABILITY	THROUGHPUT [1] ONE-WAY	THROUGHPUT [1] TWO-WAY	IMPAIRED [1]	TIA [1]	INTEROP [2]
BEST	Practical Peripherals ProClass 288LCD	$459	▲▲▲▲▲	▲▲▲▲	▲▲▲▲▲	5839	4934	6973	9307	76/80
RUNNER-UP	Hayes Optima 288 V.FC & Fax	$579	▲▲▲▲	▲▲	▲▲	5847	4930	6573	9093	60/76
RUNNER-UP	Black Box Modem 3400	$895	▲▲▲▲	▲▲▲	▲▲▲	5553	4699	5810	7458	80/80
RUNNER-UP	Hayes Optima 288 V.34 & Fax	$579	▲▲▲▲	▲▲	▲▲	5848	4445	6151	9013	72/72

Evading the ever-elusive street price

LOW COST (LESS THAN $400) — Maxtech/GVC XM288E



The $199 Maxtech/GVC XM288E and the $299 Hayes Accura v.34 turned in virtually identical performance results. The Hayes excels in features, the Maxtech in usability. The Maxtech does what you want without the flashy LCDs, designer case, and high price tag. It also includes a five-year warranty. The Hayes modem delivers excellent performance and good features, but it doesn't support the high DTE (data terminal equipment) rate that the Optimas deliver or synchronous mode transfers. The Logicode Quicktel has the best features list of this group, and the Taiwanese Lectron Pragmatic is next. It doesn't offer a U.S. support number, but we didn't need any. And the Zoom v.34x was our big winner in interoperability, completing the highest percentage of possible connections.

	MANUFACTURER/MODEL	PRICE	OVERALL SCORES	FEATURES	USABILITY	THROUGHPUT [1] ONE-WAY	THROUGHPUT [1] TWO-WAY	IMPAIRED [1]	TIA [1]	INTEROP [2]
BEST	Maxtech/GVC XM288E	$199	▲▲▲▲	▲	▲▲▲▲	5584	4733	5908	7597	76/96
RUNNER-UP	Hayes Accura v.34	$299	▲▲▲▲	▲▲	▲▲	5846	4261	5729	8814	68/72
RUNNER-UP	U.S. Robotics Sportster V.34 288	$339	▲▲▲▲	▲▲	▲▲▲▲	5493	4240	5917	7725	68/92
RUNNER-UP	Logicode Quicktel	$279	▲▲▲▲	▲▲▲▲▲	▲▲▲▲	5508	3458	5593	6744	72/68
RUNNER-UP	Lectron Pragmatic DL1428RF	$200	▲▲▲▲	▲▲	▲▲▲▲▲	5464	3507	5418	7571	88/88

[1] Bytes per second; higher numbers are faster. [2] Percent V.34 calls/percent V.34 answers.

How We Tested

We received identical pairs of modems from each vendor and subjected them to seven different telephone line conditions and five kinds of data transfer tasks. We used Microsoft Windows 3.1 to drive the data through the modems, using serial communications enhancement software to take advantage of the 16550 UART (universal asynchronous receiver/transmitter) buffer chips and to overcome the limitations of the standard Windows communications driver. The test lines represent the findings from comprehensive TIA (Telecommunications Industry Association) surveys of lines in the U.S. Our performance tests also include varying amounts of line impairments.

THROUGHPUT TESTS

During throughput tests, modems transfer three types of files ranging in size from 131 to 333 KB. We measure each pair of modems for one-way and two-way transmissions over "central-office impairment conditions," a minimally impaired telephone line that represents most of the calls made in the U.S.

IMPAIRMENT TESTS

We selected six lines with specific local loop conditions. The most difficult lines are based on the V.56bis standard on the Intercontinental Network Model. Each line introduces a different combination of impairments: long satellite delays, phase roll, and noise. We connect like pairs of modems to a TAS series II modem tester that simulates the trunk line and local loops at both ends of the connection. The modems perform a one-way transfer over a given line at least 10 times.

Most of the modems negotiated the first four impaired lines without much difficulty. However, they were not as successful with the V.56bis lines. None of the external modems was able to negotiate the 16A.6.6 line at all. Only one PC Card, the Megahertz, was able to connect, and it could only do it once (a minimum of four connects is required for a successful test).

TIA LINE TESTS

For these tests, we adhered strictly to the guidelines specified by Table 6 in the TIA bulletin TSB37-A. Following the procedures outlined in TSB-38, each modem negotiated each line once to transfer the TAS compressed file.


Hayes ESP board

FAX TESTS

We used Microsoft Windows for Workgroups 3.11 to send a single-page fax to a Brother Intellifax 620, a Hewlett-Packard OfficeJet, an Okidata DOC-IT 3000, a Sharp FO-510, and a Toshiba TF50. Only one modem failed this test. The scores are closely clumped because the fax machines transmit and receive data at a slower rate and thus limit the modems' performance.

INTEROPERABILITY

We gave each external modem three opportunities to call every other modem and transmit a single file. The scores represent a percentage of the successes (V.34 calls/V.34 answers). PC Card modems performed a similar test with six different external modems.



FEATURES AND EASE OF USE

We evaluated the modems on their features, such as their ability to spoof, the protocols they support, and the availability of on-line help. For PC Card modems, we looked at their connectors, slot type, and software. Ease of use includes the thoroughness of the documentation as well as the ease of installation and availability of customer support.

MODEM TEST EQUIPMENT

We connected identical pairs of modems to a TAS series II modem tester manufactured by Telecom Analysis Systems (Eatontown, NJ). The TAS is able to simulate most line conditions found throughout the world, including the central-office impairment conditions as specified in TIA line 17C: "There is mild white noise (22.0 dBm), second-order nonlinear distortion (55.0 dB compressed), third-order nonlinear distortion (56.0 dB), near echo (40.0 dB), far echo (20.0 dB), and a short satellite delay (27.1 ms). The loop emulator generated an EIA1 at both ends of the connection. This condition represents a direct connection spanning 2000 feet and is the shortest local loop." We connected the modems via the TAS to a Compaq Deskpro 486DX2/66M equipped with a Hayes ESP board to ensure that communications between the TAS and the modems used the 16550 UARTs (universal asynchronous receiver/transmitters). Each modem supports V.42 error correction and V.42bis data compression, which we initialized on all the modems (even if the modem's default settings specified other protocols), so our throughput test results include the affect of these features as well. We configured the modems to receive data at their fastest supported rate (up to 115.2 Kbps) and to use hardware RTS (request to send) flow control rather than XON/XOFF.


The TAS series II modem tester, from the front and from its business end.

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The Lab Report is an ongoing collaborative project between BYTE magazine and National Software Testing Laboratories (NSTL). BYTE magazine and NSTL are both operating units of McGraw-Hill, Inc. Contact the NSTL staff on the Internet at editors@nstl.com; at NSTL, Inc., or at (610) 941-9600. Contact BYTE on the Internet or BIX at editors@bix.com or at (603) 924-2643.

WHAT'S DRIVING MAXTECH?

Driven by the Power of...

EXPERIENCE • MaxTech, along with it's affiliate GVC Corporation, is the world's largest manufacturer of PC modems, networking products and computer peripherals. No wonder five of the top 10 PC manufacturers put their name on our products.

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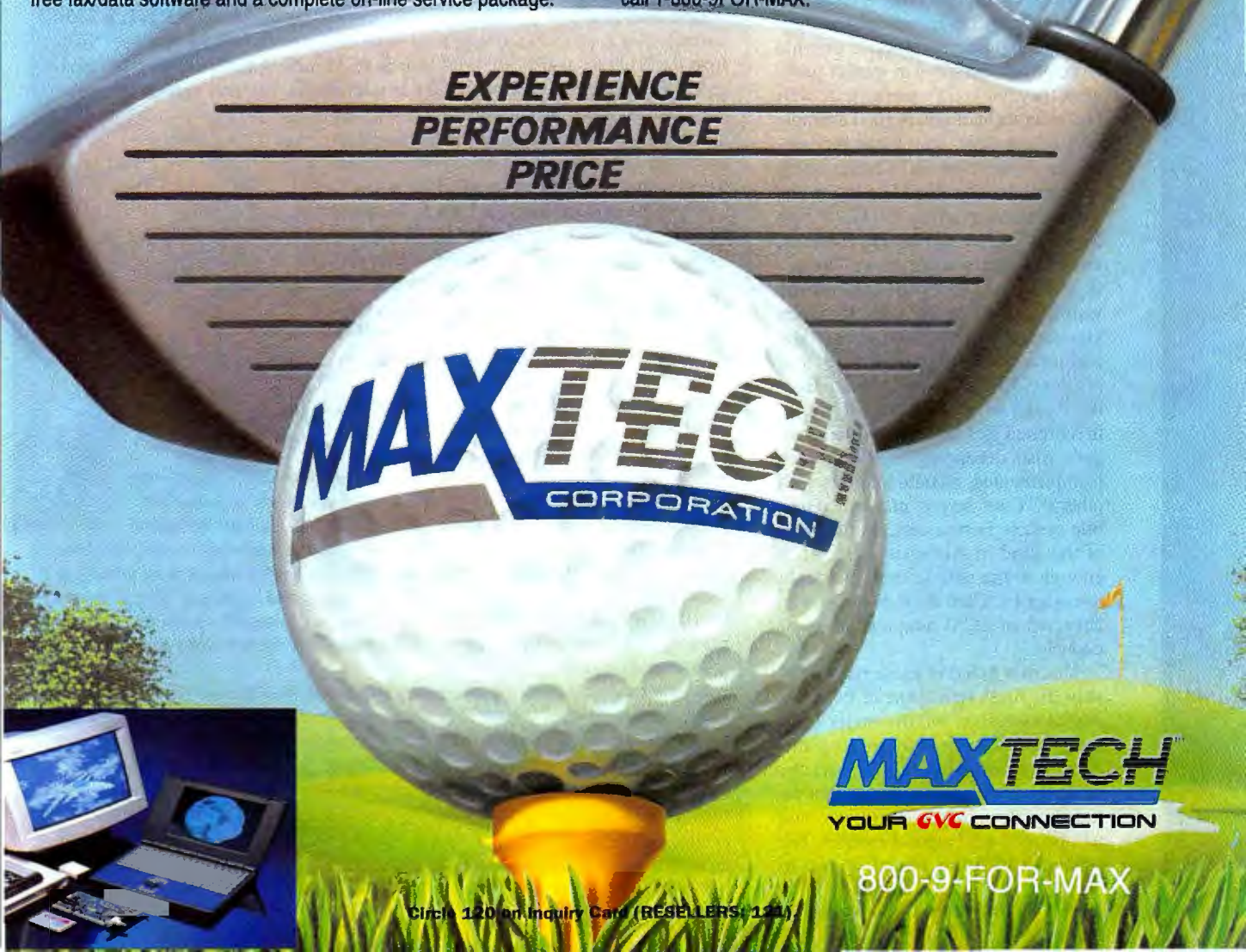
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Network Products • From 16-bit ISA NIC's to 32-bit EISA and PCI NIC's, HUBs, pocket adapters, PC cards and transceivers, MaxTech offers a complete line of network products for effortless network management.

Introducing the Yesbook™ - We took the "No" out of Notebook • Yesbook computers features a modular design which enables you to change and upgrade any key component at any time. You can custom select the CPU, the display, disk drive and more.

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Circle 120 on Inquiry Card (RESELLERS: 121)

SOLUTIONS FOR MOBILE PROFESSIONALS

PICK A PC CARD

For the first time, our modem testing has expanded into the world of PCMCIA. We tested seven modems from different vendors, and we found little to differentiate them. These modems, designed to fit into credit-card-size slots, are perfect for mobile computing. As with any modem, the concern is for short connect times, high throughput, and, hopefully, ease of use. It may seem a bit steep to pay $499 for such a little modem, but keep in mind that you are not purchasing a box. Instead, you are purchasing the convenience of communicating on the road without taking along a "luggable" modem as well as investing in an emerging technology.

But like all good things, there is a downside to this micro-technology. Even though the peripherals provide more power and speed in smaller packages, they must still communicate with big, older technology. A good example of this awkward interface is the telephone connection. PC Card modem vendors have developed an ingenious way of implementing RJ-11 in their 5-mm-thick cards. EZjack, EZ-Port, and XJack are examples: The retractable RJ-11 jack pops out from the visible edge of the PC Card for when you need to connect to a phone line, and it tucks neatly back in when you are done. But the connectors are fragile. Rough handling can easily result in a broken jack and an unusable modem. Also, depending on how the jack is implemented, it could interfere with other PC Card devices in a loaded mobile system. Fortunately, all the jacks of this kind in this issue were offset enough to the side so that you could use other PC Card devices, such as an Ethernet or SCSI adapter, simultaneously.

This new breed of modems is probably the most standardized PC Card device available. All the major Card and Socket Services software programs offer at least minimal support for modems. Each of the modems that we tested came with its own software, and all operated with a point enabler. The advantage of using a point enabler to

Make Analog Connections on Digital Phone Lines Sans Destruction

There is nothing more frustrating than trying to make modem connections behind digital PBXes while in a hotel or at client sites. If there isn't a dedicated analog line for your modem, how do you send off your E-mail over a PBX line (the most common office phone system)? On top of that, there's a chance you can accidentally fry your PC Card modem by transmitting over digital PBX lines that carry higher voltage than analog lines.

Most modems are designed to work exclusively on analog phone lines. Directly connecting modems to certain PBXes, multiphone line jacks, and digital line jacks can subject the modems to excessive electrical current, resulting in a blown fuse, disabling DAA (data access arrangement) to a data line. This failure occurs because the digital line jacks don't use the same pins for tip and ring. These concerns have started a market for computer/telephone interface products that make connections on digital, PBX, hotel, and international telephones. Several devices let you connect your analog modem into a telephone handset so that you can use any digital line.

Unlimited Systems' ((619) 622-1400) Konexx Konnector Model 111, a $159 portable device, protects modems from being destroyed by high voltage (see "Tales from the Trip" on page 159). It creates an RJ-11 jack at any telephone. The Model 111 is compatible with V.FC/V.34 specifications. You just unplug the coiled handset cord from the telephone base unit, plug in the Model 111, and plug the handset cord into the Model 111. A telephone level switch matches the modem signal to the telephone's signal.





Above: Unlimited Systems' Konexx Konnector Model 111. Right: IBM PC Company Peripheral Products' Modem Saver.

A similar analog/digital bridge is Radish's ((800) 474-5001) InsideLine ($119.95). It connects standard modems into the telephone systems of most multiline business systems. InsideLine feeds modem signals into the telephone base via its handset jack and matches signal levels to the requirements dictated by the base. The phone handset itself reconnects to InsideLine. This arrangement maintains the proprietary connection between the phone and host PBX or key system. Also among this genre of connectors is TeleAdapt's ((408) 370-0515) TeleSwitch, a $149.99 device that eliminates the frustration of trying to find an analog line when you're not on home turf.

For basic PBX protection while on the road, IBM PC Company Peripheral Products' ((704) 595-7716) Modem Saver is a $29 pen-size device that clips on a shirt pocket and detects when it's OK to connect an analog device to an unfamiliar phone line. You just insert it into the telephone jack and indicators let you know if the line is safe and warns you if the modem can be damaged by currents above 90 milliamperes. However, this is just a warning device and does not offer real protection against modem failure.

Several modem makers are integrating safeguards that prevent you from blowing a fuse. Representatives of Hayes Microcomputer Products say that they have not yet encountered a PBX-fried modem but have started installing a high-current resistor in PC Card modems to provide "a comfort factor" for users. Modems from Megahertz with the C40 chip set include a Digital Line Guard that disconnects the modem when the current exceeds 125 mA.

—John McDonough

power up the modem and set the necessary parameters (e.g., speed, parity, and data/stop bits) is that the enabler is not memory-resident. Once you configure the mode and terminate the enabler, you free the memory for other applications. This greatly reduces the overhead that complex communications software produces.



The installations for the DOS point enabler can be tricky if you're unaccustomed to selecting interrupts and port addresses. Most modems have unique enabler software. Don't be fooled by the enabler's name (e.g., ENABLER.EXE). More than likely, if you switch modems, you need a new executable and a new initialization string. Documentation was often cryptic as to where to find the appropriate command line for the enabler. Freeing memory is less of an issue in desktop systems that tend to be highly expandable than it is in mobile systems, where there is little space for installing extra SIMMs and where power conservation is a major consideration.

Now for the good news. The performance of PC Card modems on a fairly clean telephone line approaches that of the high-end externals and far exceeds that of the only-average V.34s. In fact, if we had based our rankings solely on throughput, interoperability, and fax scores, the top two PC Card modems would place third and fourth overall. Unfortunately for the PC Card devices, we also consider performance under less-than-ideal conditions. In the TIA tests, we subject these modems to 36 different line/loop conditions while transferring a small file. Because the TIA tests are executed only once (unless the modem fails, and then we retest it), the scores represent a general "feel" for how well a modem can perform under adverse conditions. The PC Card modems averaged about 300 bytes per second less than their external counterparts. The difference in the impaired line testing, where we make modems repeatedly transfer a much longer file, is even more dramatic. Here, the difference is a staggering 2500 bytes per second. The moral: If you are going abroad and expect to use your modem reliably, you may want to consider dragging an external one along just in case.



BYTE BEST — V.34 PC CARD MODEMS

Looking for high speed and interoperability?

BEST OVERALL — Practical Peripherals ProClass PCMCIA 288 with EZ-Port



The Practical Peripherals ProClass PCMCIA 288 modem finished with slightly lower performance numbers than the Hayes Optima but had noticeably higher usability numbers. It also tied for top honors on our PC Card interoperability testing. It comes with a retractable phone jack (EZ-Port), and during testing, one of the two wires inside snapped off, rendering the modem useless. Once replaced, the modem ran extremely well, finishing first in our PC Card fax testing. It also lists for $40 less than the cost of the Optima 288 V.34 card. On the other hand, the Optima has several interesting features, including integrated overload protection, which prevents the unwary user from inadvertently "frying" the modem on a hotel PBX line.

	MANUFACTURER/MODEL	PRICE	OVERALL SCORES	FEATURES	USABILITY	THROUGHPUT[1] ONE-WAY	THROUGHPUT[1] TWO-WAY	IMPAIRED[1]	TIA[1]	INTEROP[2]
BEST	Practical Peripherals PCMCIA 288	$459	▲▲▲▲▲	▲▲▲▲	▲▲▲	5751	4819	4759	7179	83/100
RUNNER-UP	Hayes Optima 288 V.34 & Fax	$499	▲▲▲▲▲	▲▲▲▲	▲	5752	4732	5477	7884	67/83
RUNNER-UP	Megahertz V.34 PCMCIA	$449	▲▲▲▲	▲▲▲	▲▲▲▲▲	5491	4353	4052	6744	33/83
RUNNER-UP	U.S. Robotics Sportster 28.8	$499	▲▲▲▲	▲▲	▲▲▲	5471	4256	5109	7424	83/100
RUNNER-UP	TDK Systems DF2814	$469	▲▲▲▲	▲▲▲	▲	5485	5857	5938	7047	100/50
RUNNER-UP	Microcom Travel Card 28.8P	$349	▲▲▲▲	▲▲	▲▲▲	5612	3588	5152	7522	50/50
RUNNER-UP	Multi Tech MT2834LT	$399	▲▲▲	▲▲▲	▲▲▲▲▲	5037	2286	4369	6604	83/17

Fast data mover

BEST DATA — Hayes Optima 288 V.34 & Fax



The Hayes Optima 288 V.34 & Fax is the big winner based solely on data throughput. It has the best one-way throughput results of all the PC Card modems we tested. The Hayes also handled the TIA testing better than the others did. The Optima is the only PC Card modem we tested that supports synchronous communication (with optional Hayes software). Practical Peripherals ProClass is the first runner-up, thanks to its five-year warranty and excellent one-way throughput scores. Its support for flash-ROM upgrades renders it less likely to become obsolete as quickly as those that don't support this option.

	MANUFACTURER/MODEL	PRICE	OVERALL SCORES	FEATURES	USABILITY	THROUGHPUT[1] ONE-WAY	THROUGHPUT[1] TWO-WAY	IMPAIRED[1]	TIA[1]	INTEROP[2]
BEST	Hayes Optima 288 V.34 & Fax	$499	▲▲▲▲	▲▲▲▲	▲	5752	4732	5477	7884	67/83
RUNNER-UP	Practical Peripherals PCMCIA 288	$459	▲▲▲▲	▲▲	▲▲▲	5751	4819	4759	7179	83/100
RUNNER-UP	Megahertz V.34 PCMCIA	$449	▲▲▲▲	▲▲	▲▲▲▲▲	5491	4353	4052	6744	33/83
RUNNER-UP	U.S. Robotics Sportster 28.8	$499	▲▲▲▲	▲	▲▲▲	5471	4256	5109	7424	83/100
RUNNER-UP	Microcom Travel Card 28.8P	$349	▲▲▲	▲▲	▲▲▲	5612	3588	5152	7522	50/50
RUNNER-UP	TDK Systems DF2814	$469	▲▲▲	▲▲	▲	5485	5857	5938	7047	100/50
RUNNER-UP	Multi Tech MT2834LT	$399	▲▲▲	▲▲	▲▲▲▲▲	5037	2286	4369	6604	83/17

[1] Bytes per second; higher numbers are faster. [2] Percent V.34 calls/percent V.34 answers.

KEY

Ratings from 1 to 5: ▲ is the lowest; ▲▲▲▲▲ is the highest.

HONORABLE MENTIONS



The Practical Peripherals ProClass 288LCD, our winner in the Overall and Data categories, sports the largest LCD panel. No longer content to just beep, scream, and flash at us, modems are beginning to express themselves better. The 288LCD updates you on connect status, connect time, line conditions, compression status, and it lets you configure the modem at the modem, eliminating much of the need to learn and input Hayes AT commands.

The Telebit FastBlazer 8840 may be more suited to high-end network use, with its numeric keypad on the front and LCD screen that are well suited for network administration. The FastBlazer is just as informative as the Practical Peripherals ProClass 288LCD, with the exception that at test time, it could not communicate line conditions. By now, Telebit should have released a firmware upgrade that will support this function.



PC Card EZjacks, EZ-Ports, and XJacks are attached RJ-11 phone jacks. Now you don't have to use little dongles or extra cables; phone lines fit right into the modems' retractable jacks. On the downside, these jacks do not let you simultaneously use the phone, forcing you to detach the phone cord from the jack. We found out the hard way that frequent attaching and detaching stresses the tiny wires that form the connection, and they are apt to break.



The U.S. Robotics Sportster comes with a different kind of PC Card phone jack. Even though it isn't a retractable jack (you could lose it), it clips into the modem giving you the security of knowing the cable will not slip. Also, the jack has two inputs, letting you use the telephone simultaneously without having to plug and unplug the jack from the modem.



WHAT DOES IT REALLY MEAN?

If you have delayed purchasing a modem until V.34 arrived, you may find the information on the modem box akin to reading the side of a cereal box (you know there's a lot in the product, but you aren't quite sure what it all means). Here's a list of some of the more common features and what they really mean.

Flash ROM
The modem is software upgradable, often as simple as typing DOWNLOAD modem.

V.42bis and MNP 5 for 4-to-1 compression
The modem can compress files, but 4-to-1 compression can be achieved only with V.42bis and a compressible file. Files created with utilities like ZIP or ARC are already compressed and would not benefit from these protocols. When the transmitting modem detects redundant units of data, it recodes them into shorter units of fewer bits. The receiving modem then decompresses the redundant data units before passing them to the computer.

V.42 or MNP error correction
Any modem that supports compression must also support its companion error-correction protocol. V.42 uses LAPM (Link Access Procedure for Modems). LAPM is an error-control protocol incorporated in ITU-T Recommendation V.42. As with the MNP, LAPM uses CRC (cyclic redundancy check) and retransmission of corrupted data (ARQ) to ensure data reliability.

Data throughput of up to 115,200 bps
Transfer rates this high for an external modem require a serial port with at least a 16550 UART (universal asynchronous receiver/transmitter). The UART is a chip that transmits and receives data on the serial port.

Compliant with V.34 and V.FC
Modems are designed to "speak" the official V.34 protocol and the earlier V.FC Rockwell modulation scheme, as well as v.FAST.

Data rates or data transmission of up to 28.8 Kbps
The data or DCE (data communication equipment) rate is the maximum modem-to-modem speed that a modem can attain. Modems negotiate the DCE rate during the handshaking process. Note that the modems can go only as fast as the slowest modem in the link will allow. This speed is dependent on the protocol that is used (e.g., V.34).

Fall back/Fall forward
Fall back is the ability of a modem to change its transmission speed downward automatically when it encounters an overly noisy line (e.g., a 28.8-Kbps modem might fall back to 14.4 Kbps.) When the line condition improves, modems that support fall forward will renegotiate a higher transmission rate.

Satellite delay
When you communicate with telephone networks that use satellites to transmit signals, the process of beaming a signal to a satellite and routing it to the receiving land station results in a delay. This delay can be disastrous to some modems.

Spoofing
Spoofing allows older software, using older protocols, to run efficiently at higher speeds. Modems that spoof accelerate XModem and other stop-and-go protocols by returning a false acknowledgment as soon as a packet is sent from the DTE to the modem.

SOME OF THE V.PROTOCOLS

V.34
The newest ITU-T (International Telecommunication Union—Telecommunication) standard allows data rates up to 28.8 Kbps and line-probing capability.

v.FAST
The interim standard that preceded the ITU-T V.34 standard and is similar to it.

V.FC (V.FAST CLASS)
When the ITU-T delayed in approving the V.34 standard, Rockwell developed a proprietary modulation scheme for data communications speeds of up to 28.8 Kbps.

V.32bis
An ITU-T standard that extends the V.32 connection range: 4800, 7200, and 9600 bps, as well as 12 and 14.4 Kbps. V.32bis modems fall back to the next lower speed when line quality is impaired, and fall back further as necessary. They fall forward to the next higher speed when line quality improves.

V.42
An ITU-T standard for modem communications that defines a two-stage process of detection for LAPM error control.

V.42bis
An extension of ITU-T V.42 that defines a specific data communications compression scheme for use with V.42 error control.

Before you invest in the hardware, make sure you're compatible.



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Circle 77 on Inquiry Card.

EXTERNAL

ROLL CALL OF V.34 MODEMS

MANUFACTURER	MODEL	LIST PRICE	PERFORMANCE: THROUGHPUT[1] ONE-WAY	THROUGHPUT[1] TWO-WAY	IMPAIRED LINES[1]	TIA LINES[1]	INTEROPERABILITY[2]
Archtek America Corp.	SmartLink 2834A	$289	4909	3963	2612	6244	72/72
Best Data Products	2834FX	$299	5474	3511	5065	7524	88/88
Black Box Corp.	Modem 3400	$895	5553	4699	5810	7458	80/80
Boca Research, Inc.	V.34 28,800 bps Boca Modem	$232[4]	5478	3865	5690	6873	68/68
Cardinal Technologies, Inc.	Cardinal 28.8 Fax/Modem	$179[4]	5474	3510	5294	7455	76/72
CXR Telcom	2845-FD1	$795	5479	4405	5516	7001	80/72
Hayes Microcomputer Products	Accura v.34	$299	5846	4261	5729	8814	68/72
Hayes Microcomputer Products	Optima 288 V.34 & Fax	$579	5848	4445	6151	9013	72/72
Hayes Microcomputer Products	Optima 288 V.FC & Fax	$579	5847	4930	6573	9093	60/76
IBM Corp.	Options Data/Fax 7852 Model 10	$287	5473	3737	5365	7581	80/96
IBM Corp.	Options Data/Fax 7852 Model 13	$429	5443	4403	5406	6044	60/60
Lectron Pragmatic	DL1428RF	$200	5464	3507	5418	7571	88/88
Logicode Technology, Inc.	Quicktel	$279	5508	3458	5593	6744	72/68
Maxtech/GVC	XM288E	$199	5584	4733	5908	7597	76/96
Microcom, Inc.	Desk Porte Fast	$519	5605	3601	5120	7722	76/36
Motorola ISG	V.3400	$895	5551	4699	5752	7532	84/80
Multi Tech Systems, Inc.	MT2834ZDX-ISI	$349	5226	3977	5586	6603	88/80
Practical Peripherals	ProClass 288LCD	$459	5839	4934	6973	9307	76/80
Supra Corp.	Supra Modem 288	$250	5460	3413	5425	6938	80/72
Telebit Corp.	FastBlazer 8840	$1199	5283	4746	4911	6467	84/100
U.S. Robotics, Inc.	Sportster V.34 288	$339	5493	4240	5917	7725	68/92
U.S. Robotics, Inc.	Courier V.Everything	$595	5466	3502	5831	7599	68/100
Zoltrix, Inc.	V.34 ZX-288	$166	5586	3610	5766	7465	76/80
Zoltrix, Inc.	V.fast ZX-288	$136	5501	3611	5426	7113	64/80
Zoom Telephonics, Inc.	Zoom V.34x	$299	5474	3501	5214	7537	84/92

PC CARD

MANUFACTURER	MODEL	LIST PRICE	PERFORMANCE: THROUGHPUT[1] ONE-WAY	THROUGHPUT[1] TWO-WAY	IMPAIRED LINES[1]	TIA LINES[1]	INTEROPERABILITY[2]	FAX[3]	MAX. SPEEDS (Kbps): DCE DATA	DCE FAX
Hayes Microcomputer Products	Optima 288 V.34 & Fax for PCMCIA with EZjack	$499	5752	4732	5477	7884	67/83	60	28.8	14.4
Megahertz Corp.	V.34 PCMCIA	$449	5491	4353	4052	6744	33/83	65	115.2	14.4
Microcom, Inc.	Travel Card 28.8P	$349	5612	3588	5152	7522	50/50	61	28.8	14.4
Multi Tech Systems, Inc.	MT2834LT	$399	5037	2286	4369	6604	83/17	68	28.8	14.4
Practical Peripherals	ProClass PCMCIA 288 with EZ-Port	$459	5751	4819	4759	7179	83/100	60	28.8	14.4
TDK Systems	DF2814	$469	5485	5857	5938	7047	100/50	61	28.8	14.4
U.S. Robotics, Inc.	Sportster 28.8	$499	5471	4256	5109	7424	83/100	60	28.8	14.4

= BYTE Best. [1] Bytes per second; higher number are faster [2] Percent V.34 calls/percent V.34 answers. [3] Seconds. [4] Street price.

FEATURES CONTINUE ON NEXT PAGE

	MAX. SPEEDS (Kbps)			CHIP SETS		ERROR CONTROL/COMPRESSION				
	DCE									
FAX[3]	DATA	FAX	DTE	DATA PUMP	CONTROLLER	MNP 5	MNP 10	LAPB	LAPM	V.42BIS
	28.8	14.4	115.2	AT&T C882-29Q-5	AT&T 1633 F08 AB	●	○	●	●	●
60	28.8	14.4	115.2	Rockwell RC288DPi, R6682-269	Rockwell L3903-55P, L39/U	●	○	○	●	●
61	28.8	14.4	115.2	SGS-Thomson 7544	Motorola 68302	●	○	○	○	●
60	28.8	14.4	115.2	Rockwell RC288DPi	Rockwell L39	●	○	○	○	●
60	28.8	14.4	115.2	Rockwell R6682-21	Rockwell L3902-57	●	●	○	○	●
60	28.8	9.6	115.2	AT&T 1633	Proprietary	●	○	○	○	●
61	28.8	14.4	115.2	Rockwell R6682	Motorola 68302	●	○	●	●	●
61	28.8	14.4	230.4	Rockwell R6682	Motorola 68302	●	○	●	●	●
61	28.8	14.4	280.4	Rockwell R6670	Motorola 68302	●	○	○	○	●
60	28.8	14.4	115.2	Rockwell RC288DPi	Rockwell L39	●	●	○	○	●
60	28.8	14.4	115.2	AT&T DSP1633	AT&T Z80182-29	●	○	○	○	●
60	28.8	14.4	115.2	Rockwell RC288DPi	Rockwell L39/U	●	●	○	●	●
60	28.8	14.4	115.2	Rockwell RC6682-21	Rockwell L39U2-57	●	●	○	○	●
60	**28.8**	**14.4**	**115.2**	**Rockwell 288DPi**	**Proprietary GVC 2910**	●	○	○	○	●
61	28.8	14.4	115.2	Rockwell RC288DPi	Zilog Z8082	●	●	○	●	●
62	28.8	14.4	115.2	56002	Motorola 68302	●	○	○	○	●
68	28.8	14.4	115.2	AT&T DSP33	Zilog 182	●	○	○	●	●
60	**28.8**	**14.4**	**230.4**	**Rockwell RC288DPi**	**Highspeed 80C52**	●	○	○	●	●
60	28.8	14.4	115.2	Rockwell RC288DPi	Rockwell 3900 Series	●	●	○	○	●
	28.8	N/A	115.2	Proprietary	Proprietary	●	○	○	●	●
60	28.8	14.4	115.2	Texas Instruments C51	Intel 186 with USR code	●	○	○	●	●
60	28.8	14.4	115.2	Texas Instruments C51	Intel 186 with USR code	●	○	○	●	●
60	28.8	14.4	115.2	Rockwell RC288DPi	Rockwell L39/U	●	○	○	○	●
60	28.8	14.4	115.2	Rockwell RC288DPi/VFC	Rockwell L39/U	●	○	○	○	●
60	28.8	14.4	115.2	Rockwell RC288DPi	Rockwell L3900-55 or L3902-57	●	●	○	●	●

	CHIP SETS		ERROR CONTROL/COMPRESSION					SLOT	XJACK	CARD & SOCKET	COMMUNICATIONS
DTE	DATA PUMP	CONTROLLER	MNP 5	MNP 10	LAPB	LAPM	V.42BIS	TYPE	CONNECTOR	SERVICES	SOFTWARE PROVIDED
230.4	**Rockwell RG683-17**	**Dallas DS80C320**	●	○	○	○	●	**Type II**	●	●	**Point Enabler; Hayes PCMCIA Install Program**
115.2	AT&T DSP163x	Zilog Z80182	●	○	○	●	●	Type II	●	●	Point Enabler; System software
115.2	Rockwell RC288DPi	Zilog Z8082	●	●	○	●	●	Type II	○	●	Point Enabler
115.2	AT&T DSP33	Zilog 182	●	○	○	●	●	Type II	○	●	Point Enabler, PhoenixCard Manager Plus 3.0
230.4	**Rockwell RC288DPL**	**Dallas Highspeed 80C52**	●	○	○	●	●	**Type II**	●	○	**Point Enabler**
300.0	Rockwell	Proprietary	●	●	○	●	●	Type II	○	○	Point Enabler
115.2	Texas Instruments C51	Intel 186	●	○	○	●	●	Type II	○	●	Point Enabler

N/A = not applicable. ● = yes; ○ = no.

EXTERNAL

ROLL CALL OF V.34 MODEMS

MANUFACTURER	MODEL	FAX SUPPORT				COMMAND SETS			
		CLASS 1	CLASS 2	V.17	V.29	HAYES ESCAPE	TIES ESCAPE	BREAK ESCAPE	PROPRIETARY
Archtek America Corp.	SmartLink 2834A	●	●	●	●	●	○	○	○
Best Data Products	2834FX	●	●	●	○	●	○	○	○
Black Box Corp.	Modem 3400	●	●	●	●	●	○	○	○
Boca Research, Inc.	V.34 28,800 bps Boca Modem	●	●	●	○	●	○	○	○
Cardinal Technologies, Inc.	Cardinal 28.8 Fax/Modem	●	●	●	●	●	○	○	○
CXR Telcom	2845-FDF1	●	●	○	●	●	○	●	○
Hayes Microcomputer Products	Accura v.34	●	○	●	●	●	○	○	○
Hayes Microcomputer Products	Optima 288 V.34 & Fax	●	○	●	●	●	○	○	○
Hayes Microcomputer Products	Optima 288 V.FC & Fax	●	○	●	○	●	○	○	○
IBM Corp.	Options Data/Fax 7852 Model 10	●	●	●	●	●	○	○	○
IBM Corp.	Options Data/Fax 7852 Model 13	●	●	●	●	●	○	○	○
Lectron Pragmatic	DL1428RF	●	●	●	●	●	○	○	●
Logicode Technology, Inc.	Quicktel	●	●	●	●	●	○	●	○
Maxtech/GVC	**XM288E**	●	●	●	●	○	●	○	○
Microcom, Inc.	Desk Porte Fast	●	○	●	○	●	○	●	○
Motorola ISG	V.3400	●	○	●	●	●	○	○	○
Multi Tech Systems, Inc.	MT2834ZDX-ISI	○	●	●	●	○	●	●	○
Practical Peripherals	**ProClass 288LCD**	●	●	●	●	●	○	○	○
Supra Corp.	Supra Modem 288	●	●	●	○	●	○	○	○
Telebit Corp.	FastBlazer 8840	○	○	○	○	●	○	○	●
U.S. Robotics, Inc.	Sportster V.34 288	●	●	●	●	●	○	○	○
U.S. Robotics, Inc.	Courier V.Everything	●	●	●	●	●	○	○	○
Zoltrix, Inc.	V.34 ZX-288	●	●	●	●	●	○	○	○
Zoltrix, Inc.	V.fast ZX-288	●	●	●	●	●	○	○	○
Zoom Telephonics, Inc.	Zoom V.34x	●	●	●	●	●	○	●	○

PC CARD

MANUFACTURER	MODEL	FAX SUPPORT				COMMAND SETS				OTHER		
		CLASS 1	CLASS 2	V.17	V.29	HAYES ESCAPE	TIES ESCAPE	BREAK ESCAPE	PROPRIETARY	FLASH ROM	LEASED-LINE SUPPORT	DOS
Hayes Microcomputer Products	**Optima 288 V.34 & Fax**	●	○	●	○	●	○	○	○	○	●	**Smartcom Exec**
Megahertz Corp.	V.34 PCMCIA	●	●	●	●	●	○	○	○	○	○	N/A
Microcom, Inc.	Travel Card 28.8P	●	○	●	○	●	○	●	○	○	●	N/A
Multi Tech Systems, Inc.	MT2834LT	○	●	●	●	○	●	●	○	○	○	N/A
Practical Peripherals	**ProClass PCMCIA 288 with EZ-Port**	●	●	●	●	●	○	○	○	●	○	**QuickLink II**
TDK Systems	DF2814	●	○	●	●	●	○	○	○	○	○	QuickLink II
U.S. Robotics, Inc.	Sportster 28.8	●	●	●	●	●	○	○	○	●	○	QuickLink II

= BYTE Best. N/A = not applicable. ● = yes; ○ = no.

OTHER FLASH ROM	OTHER LEASED-LINE SUPPORT	SOFTWARE DOS	SOFTWARE WINDOWS	SOFTWARE MAC	WARRANTY (YEARS)	PHONE	TOLL-FREE PHONE	INQUIRY NUMBER
●	●	DOSFax Lite, Comit Lite	WinFax Lite, Comit Lite	QuickLink II Fax	5	(818) 912-9800	N/A	1105
○	○	Delrina 4 in 1	Delrina 4 in 1	MacCommCenter	2	(818) 773-9600	(800) 632-2378	1106
○	●	FaxTalk	FaxTalk	N/A	1	(412) 746-5500	N/A	1107
○	○	N/A	FaxWorks	MacCommCenter	5	(407) 997-6227	N/A	1108
●	○	N/A	FaxWorks, Comit	N/A	Limited lifetime	(717) 293-3000	(800) 775-0899	1109
●	○	N/A	N/A	N/A	5	(408) 435-8520	(800) 433-1425	1110
○	○	Smartcom Exec	Smartcom	Smartcom II	5	(404) 441-1617	N/A	1111
○	○	Smartcom Exec	Smartcom	Smartcom II	5	(404) 441-1617	N/A	1112
○	●	Smartcom Exec	Smartcom	Smartcom II	5	(404) 441-1617	N/A	1113
○	○	QuickLink II Plus	QuickLink II Plus	QuickLink II Plus	1	(602) 629-3200	(800) 426-2968	1114
●	●	N/A	N/A	N/A	1	(602) 629-3200	(800) 426-2968	1115
○	●	BitFax, BitCom	BitFax, BitCom	MacCommCenter	2	+886 2 5682399	N/A	1116
●	●	Delrina 4 in 1	Delrina 4 in 1	FaxLite, QuickLink II	Lifetime	(805) 388-9000	(800) 735-6442	1117
○	●	**Delrina 4 in 1**	**Delrina 4 in 1**	**FaxPro with Microphone**	**5**	**(201) 579-3630**	**(800) 936-7629**	**1118**
●	●	N/A	FaxWorks	N/A	5	(617) 551-1000	(800) 822-8224	1119
○	●	FaxTalk Plus	FaxTalk Plus	N/A	2	(508) 261-4000	(800) 487-1456	1120
○	○	MultiExpress, MultiExpress Fax	MultiModemPCS, MultiExpress PCS, MultiExpress, MultiExpress Fax, TalkShow	MacCommCenter	10	(612) 785-3500	(800) 328-9717	1122
○	●	**QuickLink II**	**WinFax Lite, QuickLink II**	**MacCommCenter**	**Lifetime**	**(805) 497-4774**	**N/A**	**1123**
●	○	Comit	Comit, FaxTalk	MicrophoneLT, Faxcilitate	5	(360) 604-1410	(800) 727-8772	1124
●	●	N/A	N/A	N/A	2	(408) 734-4333	(800) 835-3248	1125
○	○	QuickLink II	QuickLink II	MacCommCenter	5	(708) 676-7010	(800) 342-5877	1126
●	●	QuickLink II	QuickLink II	N/A	2	(708) 982-5010	(800) 342-5877	1127
○	●	N/A	BitWare Lite	N/A	5	(510) 657-1188	N/A	1128
○	●	N/A	BitWare Lite	N/A	5	(510) 657-1188	N/A	1129
○	○	Comit, DOSFax Lite	Comit, WinFax Lite	Microphone LT, MaxFax	7	(617) 423-1072	(800) 666-6191	1130

SOFTWARE WINDOWS	SOFTWARE MAC	SLOT TYPE	XJACK CONNECTOR	CARD & SOCKET SERVICES	COMMUNICATIONS SOFTWARE PROVIDED	WARRANTY (YEARS)	PHONE	TOLL-FREE PHONE	INQUIRY NUMBER
Smartcom	**N/A**	**Type II**	**●**	**●**	**Point Enabler; Hayes PCMCIA Install Program**	**5**	**(404) 441-1617**	**N/A**	**1346**
FaxWorks Data	N/A	Type II	●	●	Point Enabler; System soft	5	(801) 320-7000	(800) 527-8677	1347
FaxWorks	N/A	Type II	○	●	Point Enabler	5	(617) 551-1000	(800) 822-8224	1348
MultiExpress, Multi-Express Fax	N/A	Type II	○	●	Point Enabler, PhoenixCARD Manager Plus 3.0	5	(612) 785-3500	(800) 328-9717	1349
WinFax Lite, QuickLink II	**MacCommCenter**	**Type II**	**●**	**○**	**Point Enabler**	**5**	**(805) 497-4774**	**N/A**	**1350**
QuickLink II	STF Startfaxing, Microphone LT	Type II	○	○	Point Enabler	5	(916) 478-8421	(800) 999-4835	1351
QuickLink II	N/A	Type I	○	●	Point Enabler	5	(708) 676-7010	(800) 342-5877	1352



"We recommend the Action AXP 27 as an excellent all-around NT workstation."
BYTE Magazine, March 1995

"WHOOSH!"
Windows Magazine, March 1995

"AXP275 streaks from the gate, shatters records, the stopwatch"
Government Computer News,
February 6, 1995

"Alpha cleans Pentium's clock"
Windows Sources, February 1995

"As good as it gets if you need speed"
PC World, February 1995

"Action AXP275 runs NT at full throttle"
PC WEEK, November 7, 1994

The AXP275 offers the fastest Win32 performance we've seen..."
Windows Sources, February 1995

"Every component of this computer is representative of the best technology available."
PC World, February 1995

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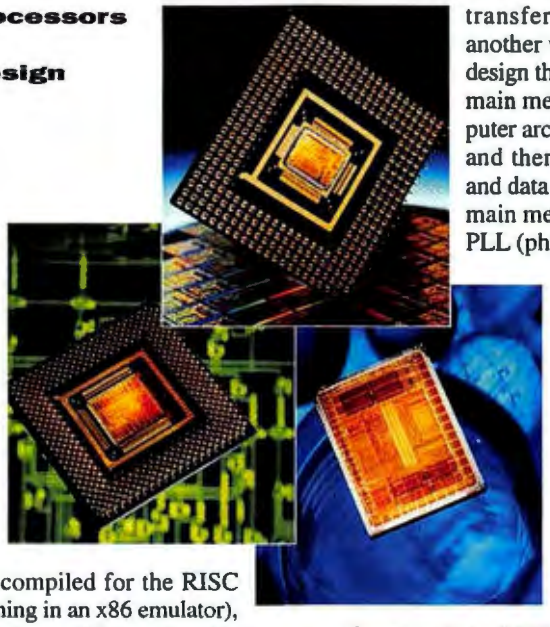
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Designing Alpha-Based Systems

Digital's trio of processors offers different design possibilities

BRUCE FAUST



In a world where speed is king, not all RISC PCs are created equal. Currently, there is a marketing battle over which of the industry titans' RISC PCs are the fastest. However, there's one unmistakable truth concerning RISC PCs: If you have ever used one and run a "native" Windows NT application (an application compiled for the RISC processor, not something running in an x86 emulator), you'll never want to go back to an x86-based system.

Consider, for example, Digital Equipment's Alpha AXP family of microprocessors. Digital's Semiconductor Operation (Hudson, MA) has developed CPUs for many years, and the Alpha comes from the microVAX family of CPUs. However, the Alpha is rather unique when compared to other RISC processors. It was designed from the beginning as 64-bit processor, which differs from other 64-bit RISC processors that have evolved from 32-bit implementations. It has 64-bit address and data lines, pipelined both in and out of the processor. Furthermore, not only is the Alpha superpipelined but superscalar as well. In a superscalar design, the CPU is issuing more than one instruction per clock tick. Digital's newest Alpha design, the 21164, issues four instructions per clock tick. This super-superscalar approach, coupled with a 300-MHz clock speed, yields a mind-bending 1.2 billion instructions per second.

There are essentially three types of Alpha CPUs. The table on page 240 shows a comparison of the Alpha family of processors. These are the 21066, 21064 (with two varieties), and 21164. As the table shows, the taxonomy of each processor is quite similar. However, there are variations in the internal cache sizes, clock speeds, and external glue logic required. With that in mind, let's start with the first member of the Alpha family.

The 21066 (PCA, PC Alpha)

The 21066's strength lies in its ready ease of integration into a PC system, hence the moniker, PC Alpha. That's because the 21066 provides all on-board cache, DRAM, and PCI (Peripheral Component Interconnect) logic signals. The PCI bus interface is 32 bits wide, which offers transfer rates of up to 132 MBps. Put another way, the designer doesn't have to design the external glue logic for the cache, main memory, or a PCI interface. A computer architect can lay out the motherboard and then attach the multiplexed address and data lines for the write-back cache and main memory. Digital added an on-board PLL (phase-locked loop) that further simplifies the implementation of the PCI interface. You supply the 21006 with an external 33-MHz clock signal, and the PLL multiplies it internally to give the processor a clock speed to either 166 MHz or 233 MHz. Meanwhile, the external hardware, such as the PCI bus, cache, and memory continue to operate at 33 MHz, simplifying design and component costs.

In some tests, the 21066 can outperform the faster 21064 family of CPUs in PCI I/O, simply because the former processor's PCI interface is efficient. The cache and DRAM bus are 64 bits wide, giving the processor bandwidth up to 264 MBps. However, because the cache and DRAM interface are time-multiplexed, the 21066 takes a performance hit relative to the 21064 and 21164 processors on memory accesses.

While the 21066's integer performance is bested by Intel's Pentium (94 SPECin92 at 233 MHz versus 112 SPECint92 for a 100-MHz Pentium), the Alpha's floating-point performance is quite impressive (110 SPECfp92 versus the Pentium's 82 SPECfp92). Floating-point computations are extremely important for such applications as rendering, animation, CAD, and other scientific applications. The strengths of the 21066 are evident in low-cost 64-bit RISC applications. If you want good floating-point performance as well as good I/O performance in a low-cost workstation, the 21066-based workstation is for you. Users of 21066-based systems enjoy about 25 percent better floating-point performance than Pentium 100 users. Base prices for 21066-based machines are under $4000.

The 21064

The 21064 was the first Alpha processor to arrive on the market, originally running at 150 MHz. Now the chip ticks along at 275 MHz. However, the 21064 requires external glue logic to interface the cache, DRAM, and PCI. The 21064 uses separate (nonmultiplexed) address and data lines; therefore, memory accesses are more efficient than in the 21066. This bus arrangement also allows such enhancements as doubling the data paths from 64 bit to 128 bits, which offers a more effective method for

minimizing wait states and maximizing cache efficiency. However, designing the cache technology to minimize the wait states from the CPU to cache memory is somewhat difficult, because a 21064 running at 275 MHz has a 4-ns (nanosecond) access cycle time. As result, even using the currently available 15-ns, 1-Mb static RAMs yields four wait states per memory access at best.

Using such cache techniques as two-set associativity and synchronous static RAMs greatly improves cache performance. For sequential data applications, it is sometimes better to operate a smaller yet faster cache, such as one 512-KB cache using 10-ns parts. In applications where the data might be accessed randomly, having a larger yet slower cache offered better performance.

ALPHA FAMILY FEATURES

Each processors features targets specific price/performance markets.

	21066	21066A	21064	21064A	21164
Total on-chip cache size	16 KB	32 KB	16 KB	32 KB	112 KB
On-chip secondary cache size	n/a	n/a	n/a	n/a	96 KB (unified data and instruction)
Die technology (micron size)	.68	.50	.75	.50	.50 to .40
Clock speed (MHz)	166	233	150, 166, 200	233, 275	266, 300, 300+
Transistor count (millions)	2.2	2.4	1.6	1.8	9.6
External data bus	64 bit	64 bit	128 bit	128 bit	256 bit
External cache (level 2)	256 KB to 1 MB	256 KB to 1 MB	128 KB to 16 MB	128 KB to 16 MB	n/a
External cache (level 3)	n/a	n/a	n/a	n/a	2 MB to 64 MB
Build in DRAM interface	●	●	○	○	○
Build in cache RAM interface	●	●	○	○	○
Build in PCI interface (32 bit)	●	●	○	○	○
External chip set required?	○	○	●	●	●
External chip set PCI interface	32 bit	32 bit	32 bit	32 bit	64 bit
Pin grid array count	287 pin	287 pin	431 pin	431 pin	499 pin
Power dissipation	22.5 W	27 W	27 W	32 W	43.5 W

● yes; ○ = no; n/a = not applicable

Newer 21064-based designs that offer *cache SIMM modules* are on the way. These cache SIMM modules are densely populated and can use fast 10-ns, 256-KB or 1-MB parts. These modules can be expanded from 2 MB up to 8 MB, allowing the 21064-based system to gain the best of both worlds: fast 10-ns access time for sequential applications and a deep cache for random-access applications. However, this makes the 21064 design more complex than developing a 21066-based machine.

Although the 21064 might be more of a design challenge for engineers, users who like the more-power approach to computing love this class of machine. Running native Window NT applications, a 275-MHz 21064 machine is about twice the speed of the Pentium 100 system, and floating-point performance is roughly four times faster than that of the Pentium. Emulated 16-bit x86 applications on the Alpha run at about the speed of a 50-MHz 486DX2. So, if you run many 16-bit applications, you might want a Pentium system instead.

The 21164

The 21164 is the newest in a series of Alpha CPUs from Digital. And this one really screams, especially when it can operate at 300 MHz. At this speed, it posts 330 SPECint92 and 500 SPECfp92. The key to this blazing performance is that the processor has a level 2 cache on-chip and issues four instructions per clock cycle. Because the level 2 cache is latched to the speed of the microprocessor, it offers zero wait states. The only exception, of course, is if the next set of data is not cached in either the level 1 or level 2 cache and must be fetched from an off-chip cache or from main memory. With cycle times now less than 4 ns, and using cache module SIMMs with 10-ns speeds, the 21164 will probably have at least four wait states. However, silicon that glues this chip to a third level cache, DRAM, and PCI interface is not yet available. Such chip sets are expected to be released later this summer. Also, the planned PCI interface is expected to be expanded to 64 bits, adding to the complexity of the ASIC design of the glue interface. Early versions of systems based on this chip will be expensive. Such systems will have complex designs and will require costly high-speed parts to keep the 21164 running at full speed. Also, the 21164 alone has a price tag of $3000—higher than the price of some PC systems.

Market Outlook

Despite the Alpha's lead in the clock and performance race, Digital clearly has a number of obstacles it must overcome to make the processor pervasive. First and foremost, more software vendors need to embrace the Alpha. Currently, a number of vendors have ported applications to the processor. To date, over 1500 vendors with applications such as Word and Excel have already been ported. However, it's the ports of such software as Microstation, Pro Engineer, and NewTek's Lightwave 3D that has fueled a boom in the Alpha-based workstation market. These applications are heavily floating-point intensive, and the native versions of these applications run circles around Pentium and even other competing RISC architectures.

Another obstacle is support silicon. Glue logic chip sets are crucial for system designers to develop hardware capable of harnessing the Alpha technology. Without this, I doubt many designers would be interested in developing programmable array logic–based motherboards. However, DeskStation (Lenexa, KS) has recently developed a chip set for the 21064 and one for the 21164. These should be available early this summer. Other vendors should follow suit.

Finally, pricing for the Alpha chip technology must entice users to make the switch from Intel or its clones over to Alpha. Time will tell if Digital has made the right gamble. ■

Bruce Faust holds a graduate degree and is founder of Carrera Computers and NekoTech. Both NekoTech and Carrera manufacture RISC PCs based on Alpha technology.

Windows 95 Graphics Architecture

New device-driver interfaces in Windows 95 help vendors of graphics boards showcase their hardware-acceleration features

STANFORD DIEHL

Armed with figures forecasting huge growth in the entertainment market and showing skyrocketing sales of multimedia-capable systems to the home, Microsoft is touting Windows 95 as a multimedia OS from the ground up. With multimedia in mind, Microsoft has revamped the graphics architecture of Windows.

Most of the improved graphics architecture of Windows 95 has already shipped incrementally as APIs for Windows 3.1. These components will be integrated under Windows 95 and will sit on top of a new set of DDIs (device-driver interfaces). They are the DCI (Display Control Interface) DDI, 3-D DDI, and GDI (Graphical Device Interface) DDI (see the figure "Windows DDI Architecture").

They will make it easier for vendors to write drivers that take advantage of specific hardware-acceleration features. The DDIs will act somewhat like DLLs for driver writers. Developers can call specific components of the DDI that their hardware can take advantage of and throw out the parts they don't need. The grand vision is a universal driver architecture for Windows 95 and, eventually, for Windows NT as well.

The DDI Model

DCI, which was developed by Microsoft and Intel, grants video codecs direct access to hardware video accelerators. A video codec can determine if the graphics hardware supports special video functions (e.g., scaling and RGB-to-YUV conversion). If so, the codec can send unscaled YUV (the color format used by motion video) data directly to the video accelerator, freeing the CPU of scaling and conversion tasks. The device driver exposes a surface of video memory. The application can then write directly into the video surface, either on-screen or off-screen. But DCI is currently only a specification; it's up to the graphics-card vendor to implement specific hardware features in a custom DCI driver. The DCI DDI will let vendors implement DCI functionality with little custom code.

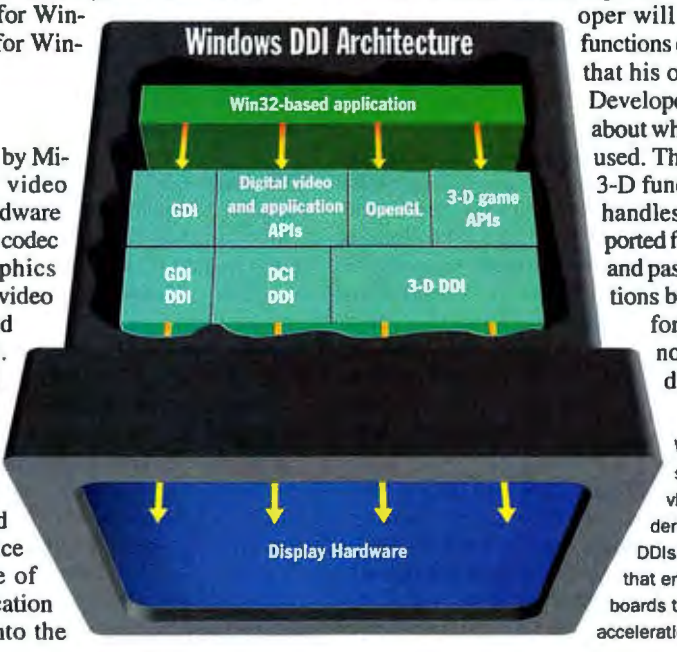
DCI has been a boon for motion video on the Windows platform. It has driven Microsoft to follow the same model for enabling hardware acceleration of other graphics functions. Microsoft announced a set of four APIs that will encapsulate what is now the DCI DDI (see the text box "DCI: The Next Generation"), extending the model beyond digital video and standardizing interfaces for sound, multiuser games, and digital joysticks.

3-D Windows

Windows 95 won't ship with an integrated 3-D engine. Microsoft says it doesn't want to impose an engine on developers who are already tied to existing 3-D APIs. Thus, 3-D engines from Render Morphics (since bought by Microsoft), Criterion, and other vendors will sit atop the 3-D DDI. As DCI does with video accelerators, the 3-D DDI will take advantage of 3-D hardware when it's available. It will allow the hardware to handle supported functions and "fill in" the gaps by emulating other 3-D functions in software. A game might display flat-shaded polygons if played on unaccelerated hardware, but on 3-D hardware, you would get smooth texture mapping while maintaining performance.

The onus is on device-driver developers to enable hardware 3-D acceleration. When 3-D DDI ships ("post-Windows 95 launch," according to Microsoft), a driver developer will enable the set of 3-D functions offered through the DDI that his or her card can handle. Developers won't have to worry about which 3-D engine is being used. The application sends the 3-D function to the DDI, and it handles the rest, sending supported functions to the hardware and passing unsupported functions back to the CPU. Therefore, 3-D applications will no longer have to support different 3-D chips.

continued



Windows 95 will provide a series of graphics APIs—for video, games, and 3-D rendering—using a new set of DDIs (device-driver interfaces) that enables vendors of graphics boards to showcase their hardware-acceleration capabilities.

Games, Games, Games

For games development (a *huge* focus of Windows 95), WinG functionality will be integrated into the DIBEngine. Developers who create their own graphic worlds can bypass the GDI by blasting DIBs (device-independent bit maps) directly to the screen. This will allow games to run as fast (or faster) under Windows as under DOS. Games developed previously with the WinG API will run as is under Windows 95.

DOS sessions should be much more robust under Windows 95. Each session can carry its own configuration environment, featuring unloadable device drivers. Dynamic drivers that uninstall after use will also free up more conventional memory under DOS. And in the single-application mode, you can dedicate all resources to a single DOS session. You cannot multitask in the single-application mode, but you can ensure an optimal configuration for a resource-hungry game.

WinToon will also be integrated into the DIBEngine. Full-screen animations will be easier to deploy on the Windows platform, and features such as chroma-keying will let developers lay animations across various backgrounds, including video.

This is where an integrated engine improves performance. In Windows 3.1, DCI works through Video for Windows. Under Windows 95, however, developers can tap into DCI when it makes sense. Animators can use the best performance scheme available: GDI, DCI, WinG, or a 3-D engine. All these components are now interlinked and talk to each other (see the figure). For instance, the DIBEngine could call a DCI video-memory surface (if a motion-video accelerator chip is present) and render a 3-D object on the video surface using specialized 3-D hardware. All these separate pieces come together in Windows 95.

DCI: The Next Generation

In Windows 95, DCI (Display Control Interface) will be enriched with four new APIs. They will provide direct interfaces for fast video, sound, multiuser games, and digital joysticks.

DirectDraw



Essentially, the new version of DCI. DirectDraw will let applications access hardware video and display surfaces directly.

DirectSound



The direct interface to sound cards. A consistent API for mixing and developing digital (WAV) sounds. Windows 95 will also support general MIDI.

DirectConnect



A set of interfaces for developing multiuser games.

Digital Joystick



Device-level interface for digital joysticks. Developers can write to one digital joystick standard to support multiple joystick vendors.

Better Video

A new Windows technology called Surround Video can create a full 360-degree graphics environment. You first create background images with existing production techniques (e.g., 360-degree photography). Surround Video blends the image together to form an endless loop, correcting image distortion through remapping algorithms. Blue-screen keying superimposes overlay images or motion video on top of the background. The view from within the interface extends right or left in a full circle. Surround Video also incorporates authoring tools and scripts for designating a sequence of scenes, including other panoramas. Hot spots link to DIBs, AVI (Audio Video Interleave) movies, audio files, or other launchable components.

A new file type, called a striped DIB, stores scan lines as vertical strips (4 pixels wide). When you scroll to a new scene (a different view of the panorama), the engine loads enough vertical strips to fill the viewable area. In this way, the entire file is never read into memory (only the initial 640- by 480-pixel image is; a full 360-degree image is typically 4000 by 480 pixels). To improve display performance, two sets of stripes—those making up the view directly to the right and the left of the current view—are loaded into memory. When you pan left or right, the corresponding stripes are blasted to the screen. (For more information on Surround Video and Apple's QuickTime VR, see "See You Around," May BYTE.)

In addition to 32-bit versions of Cinepak and Indeo, Microsoft is banking on MPEG support to enhance video playback under Windows 95. Windows won't include an MPEG codec in the box, but the MCI (media control interface) command set will incorporate MPEG control. You can load installable MPEG codecs from other vendors (e.g., Mediamatics or Xing Technologies) through MCI and manipulate the video just as you would an AVI file. Of course, DCI will directly access hardware MPEG decoders, when available, or otherwise launch MPEG decompression in software.

MPEG lets developers "scale-up" video playback. Under Video for Windows, video frames are simply dropped to keep audio and video in sync. To avoid dropped frames, developers often choose a frame rate according to the "lowest common denominator" hardware of the targeted audience. The problem? A video title captured at, say, 12 frames per second plays the same on a 486/33 computer as it does on your high-performance PCI-based (Peripheral Component Interconnect) Pentium machine.

MPEG, on the other hand, can dynamically adjust playback to meet the performance capabilities of your hardware. MPEG inserts key frames at configurable intervals. Intermediate frames look ahead and back to these key frames (i.e., bidirectional interframe compression), pointing to blocks of similar data to reference during compression and decompression. MPEG can adjust the media stream dynamically, perhaps running only key frames on a slower machine or sampling audio at only 11 kHz. On a hardware-assisted system, the same MPEG stream could run at a full 30 fps with 44-kHz audio.

Multimedia 95

Clearly, Microsoft has done a lot of work to make Windows 95 a true multimedia OS. The success of this initiative will depend on the stability and robustness of the platform as well as on third-party vendors adhering to the Microsoft call to arms: quality 32-bit applications, ease-of-use features, and light footprints.

Where to Find

Microsoft Corp.
Redmond, WA
(800) 426-9400
(206) 882-8080
fax: (206) 635-6100

Consumers of multimedia may have a distorted view of what Windows 95 can deliver. It looks like a solid multimedia OS, but it is not designed to run optimally on low-end systems. For true multimedia applications, you'll need some fairly beefy hardware to take advantage of the architecture's scalable design. If you want to play, ante up a PCI Pentium. ■

Stanford Diehl is director of BYTE reviews. You can reach him on the Internet or BIX at sdiehl@bix.com.

Adding Apple Events to Your Mac Application: Part 2

This final installment illustrates how to write the event handlers and the dispatch table

TOM THOMPSON

Last month's column, Part 1 of this series, described how Apple Events function as a high-level means of IAC (Interapplication Communication). This month's installment will finish up the series, completing the task of adding Apple Event capabilities to your Mac application.

Part 1 left off at step two of the process, in which you build the application's dispatch table. The listing "Building the Dispatch Table" shows the data structure and `for` loop used to accomplish this. The loop calls another Apple Event Manager function, `AEInstallEventHandler`, with the elements of an event's class number, its ID number, and a pointer to the handler function.

It's crucial to use `NewAEEventHandlerProc()` on the pointers you supply. This sets up universal procedure pointers to these functions. This way, the Power Mac's OS can safely context-switch to the handler code's instruction set (which could be either PowerPC or 680x0). This takes care of step two.

Step three is to write the handlers themselves. The code to these is shown in the listing "The Four Event Handlers." Notice that we punt on handling an Open Application and Print Document event: That's because application designs vary so widely that there's no good generic code example possible.

However, these code stubs show what your application must do to respond to required Apple Events in a given situation. For our Open Application event, we merely do nothing and return a "no error" code (`noErr`), indicating that things are OK.

If your application doesn't happen to support printing, you return a code of `errAEEventNotHandled` to inform the calling application that no service is possible for that request. For a Quit Application event, all you have to do is knock down the flag that keeps the main event loop active. Upon leaving the main event loop, your application performs any housekeeping chores and exits.

The Open Document handler code shows how your application receives filenames through a high-level event. It uses a boatload of Apple Event Manager calls to pick apart the event for the information you need.

First, you call `AEGetParamDesc()` to extract the para-

Building the Dispatch Table

```
// Structure for installing handlers into AE event dispatch table
struct AEinstalls
  {
    AEEventClass theClass;
    AEEventID theEvent;
    AEEventHandlerProcPtr theProc;
  };
typedef struct AEinstalls AEinstalls;

// Build high-level event dispatch table and add our handlers to it.
// Must use static declaration so the dispatch table has file scope.
Boolean Init_AE_Events(void)
{
OSErr    err;
short    i;
static AEinstalls HandlersToInstall[] = // The four required Apple Events
  {
     {kCoreEventClass, kAEOpenApplication, Core_AE_Open_Handler},
     {kCoreEventClass, kAEOpenDocuments, Core_AE_OpenDoc_Handler},
     {kCoreEventClass, kAEQuitApplication, Core_AE_Quit_Handler},
     {kCoreEventClass, kAEPrintDocuments, Core_AE_Print_Handler},
    };

    for (i = 0; i < LAST_HANDLER; i++)
     {   // Install each handler in application dispatch table
     err = AEInstallEventHandler(HandlersToInstall[i].theClass,
           HandlersToInstall[i].theEvent,
NewAEEventHandlerProc(HandlersToInstall[i].theProc), 0, FALSE);
    if (err)          // If there was a problem, bail out
        {
        Report_Err_Message (PROBLEM_WITH_AE_HANDLER);
        return FALSE;
        } // end if
    } // end for

  return TRUE;
} // end Init_AE_Events()
```

The Four Event Handlers

```
// High-level open application event.
pascal OSErr Core_AE_Open_Handler(AppleEvent *messagein, AppleEvent *reply, long refIn)
{
     return noErr;
} // end Core_AE_Open_Handler()

// High-level open document event
pascal OSErr Core_AE_OpenDoc_Handler(AppleEvent *messagein, AppleEvent *reply, long refIn)
{
short            i;
AEDesc           fileDesc;
OSErr            highLevelErr;
AEKeyword        ignoredKeyWord;
DescType         ignoredType;
Size             ignoredSize;
long             numberOFiles;
FSSpec           inFSS;

 if (!(highLevelErr = AEGetParamDesc(messagein, keyDirectObject, typeAEList, &fileDesc)))
     {
     if ((highLevelErr = AECountItems(&fileDesc, &numberOFiles)) == noErr) // Count files
        {
        for (i = 1; ((i <= numberOFiles) && (!highLevelErr)); ++i)
            {
            if (!(highLevelErr = AEGetNthPtr(&fileDesc, i, typeFSS, &ignoredKeyWord, &ignoredType,
               (char *)&inFSS, sizeof(inFSS), &ignoredSize))) // Get each name
               {
               Do_Your_Stuff(&inFSS);
               } // end if !highlevelErr
            } // end for
        } // end if == noErr
        highLevelErr = AEDisposeDesc(&fileDesc); // Dispose of the copy made by AEGetParamDesc()
     } // end if !highLevelErr

 return highLevelErr;
} // end Core_AE_OpenDoc_Handler()

// High-level print event
pascal OSErr Core_AE_Print_Handler(AppleEvent *messagein, AppleEvent *reply, long refIn)
{
    return errAEEventNotHandled;        // No printing done here
} // end Core_AE_Print_Handler()

// High-level quit event
pascal OSErr Core_AE_Quit_Handler(AppleEvent *messagein, AppleEvent *reply, long refIn)
{
    guserDone = TRUE;              // Tell main event loop we want to stop
    return noErr;
} // Core_AE_Quit_Handler()
```

meters from the event's data structure. This function coerces the parameters into an array known as a *descriptor list* and drops it into the buffer pointed to by `fileDesc`.

Next, `AECountItems()` determines the number of objects in the list, which is the number of files to open. The value returned by this function sets up the `for` loop used to collect the filenames.

Finally, `AEGetNthPtr()` gets the filenames from the descriptor list. The filenames are coerced into file-system specification records (`typeFSS`), a format used by most System 7 File Manager functions. When the filenames are in a form that's usable by the Mac OS, your application can perform the requested processing on their contents. Note that this same code can be used to get the filenames for a Print Documents Apple Event.

Finally, you need to let the Mac OS know that your application can process Apple Events. To do this, you must set the `isHighLevelEventAware` bit in the application's SIZE resource. If you fail to set this bit, the Mac OS never sends high-level events to your application. Most development environments provide a menu that lets you easily set this bit.

Where to Find

Apple Computer, Inc.
Cupertino, CA
(800) 776-2333
(408) 996-1010
fax: (408) 996-0275

These snippets of code should help give you a jump-start on adding Apple Event capabilities to your Mac application. To obtain the *Apple Event Registry: Standard Suites* document mentioned in Part 1, which lists the structure and content of certain types of Apple Events, contact the APDA (Apple Programmer's and Developer's Association) at (716) 871-6555 or by fax at (716) 871-6511. Ask for part number R0130LLA. It costs $85.

Another excellent source of information, where all those dense technical IAC concepts are translated into something a typical programmer can comprehend, is Dave Mark's *Ultimate Mac Programming Secrets* (IDG Books, 1994). It also has a lot of code samples on CD-ROM, the best training material of all. ■

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Simplifying Remote Management

Standards-based remote monitoring takes hold

SALVATORE SALAMONE

Two trends—decentralization of organizations and the growing use of LANs—have created a challenge for network administrators. They find themselves responsible for keeping LANs in many remote locations up and running.

A big part of the problem is that many smaller sites cannot afford to have full-time technical staffers to handle problems. Even simple problems can be a pain. After all, you can't expect a person who has little experience with computers to attach a protocol analyzer, such as the full-function Network General Notebook Sniffer Analyzer, to the network and diagnose the problem on their own. (And that's not to disparage protocol-analyzer manufacturers, who have been making their products easier for networking professionals to use.)

Recognizing that managers need to somehow see what's going on at distant locations, the IETF (Internet Engineering Task Force) has developed specifications for an RMon (remote monitoring) system that keeps tabs on the state of distant networks. RMon is an extension of the IETF's SNMP, which is commonly used to manage large networks. The idea behind RMon is to distribute, throughout a network, probes that collection information about the traffic on that network.

The difference between SNMP and RMon is that SNMP monitors and manages network devices like hubs and bridges, while RMon monitors LAN traffic. With RMon, some of the management intelligence is moved out onto the network, where RMon probes alert a centralized console whenever a threshold, such as number of packets, is exceeded.

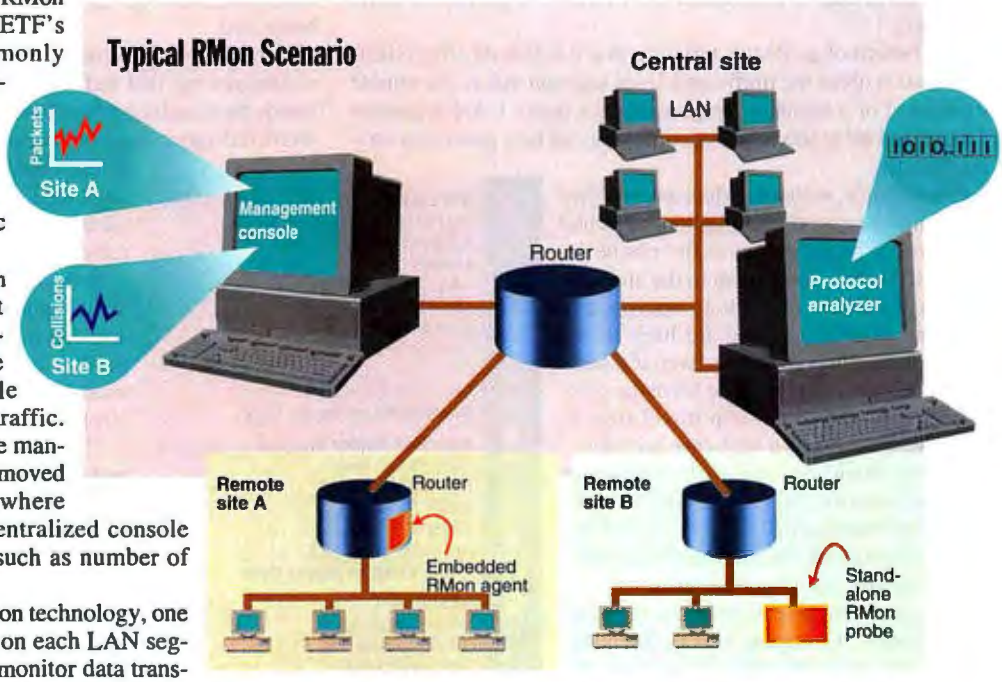
In a typical use of RMon technology, one probe would be located on each LAN segment. The probe would monitor data transmission on that segment and organize the information it collects into a format that makes it easy for a manager at a central site to analyze traffic patterns and diagnose problems at remote sites.

Because of these helpful features, RMon is taking off. Virtually all router and intelligent-hub vendors are offering RMon capabilities in their products or say they soon will. Other companies, such as Armon Networking, offer stand-alone RMon probes that connect directly to Ethernet or Token Ring LANs. Armon's product is called On-Site. And many protocol-analyzer vendors, such as Network General, are offering RMon probes.

While RMon has great potential to help network administrators better manage remote-site LANs, there is some confusion about what role an RMon probe plays in traditional network analysis and troubleshooting. The major point of confusion is a belief that RMon probes will obviate the need for traditional protocol analyzers.

That's simply not the case. In fact, most networks would do well to employ both RMon technology and protocol analyzers. The two perform complementary, not competing, functions. An analogy might help explain the difference between an RMon probe and a protocol analyzer. In general, it's the difference between knowing that the editor of BYTE got 50 letters and knowing what opinions were expressed by readers in those letters. Analogously, when deployed throughout a network, RMon can give a network manager good statistical and trend information about the number of packets passing over the network.

continued



RMon probes distributed throughout a network collect traffic information that is called up on a central management station. Protocol analyzers are then attached to a LAN segment when more detailed packet analysis is needed.

A protocol analyzer is able to take a captured packet and decode all seven of its protocol layers.

Naturally, there's some overlap in the functions of an RMon probe and a protocol analyzer. For example, many protocol analyzers can perform trend analysis on the data they collect.

The way the two technologies can work to complement one another is to use RMon to baseline networks, study usage trends, and identify potential problems before they cause trouble for users. This will help reduce the number of trips to remote sites that technicians must make to solve problems (see the figure).

And when a problem requires higher-level diagnostics to be performed, use a protocol analyzer. For example, a person could go to a troubled site with a laptop running Comtest's protocol analyzer, NM Elite. This Ethernet network analysis and testing tool includes an alarm and event log, as well as an expert system that helps diagnose common network problems. (NM Elite was the winner of BYTE's Best of CeBIT award in the connectivity software category.)

It's in the Details

The type of information an RMon probe might collect is how many packets and what size packets are transmitted on the LAN segment. It will also look at the number of packets broadcast and collisions. This information could be used to spot a defective adapter card, which is bombarding the LAN with bad packets causing poor performance.

RMon probes can also collect a trace of the traffic on the LAN segment over a period of time and pass this trace to a central site for analysis. This feature of an RMon probe can be used to study traffic patterns and perform trend analysis of the bandwidth demands of the users on that segment. One of the most important features of an RMon probe is that it can be used to send alerts and alarms to network management systems if a preset threshold of some network parameter has been exceeded (e.g., if collisions exceed a level that is considered the norm for a particular LAN segment).

The benefit of an RMon system is that it automatically collects information about the traffic on a LAN segment that is in a remote location. For a manager responsible for many LAN segments that are not all in the same location, that can be a great cost-saving benefit.

For example, without RMon, any problem called into a network troubleshooting center that cannot be solved over the phone requires a trip by a technician to the site. The cost implications of such an approach to network troubleshooting are high. First, there's the technician's time. Even if it takes him or her only 15 minutes to solve the problem, there's the round-trip travel time to consider. And that's a best-case scenario.

Whom should you send to the remote site when a network fails? It's hard to know whether a router or CSU/DSU (channel service unit/data service unit) has failed, or if there's trouble with the leased line.

Without being able to diagnose the problem remotely, a company may first send the wrong person to the site. This wastes that person's time and leaves the problem to be resolved. Adding to the cost of problems at remote sites is the fact that even if the right person goes to the site and solves the problem instantly, the people working there are stymied until the technician arrives. If it takes a technician 2 hours to get to a site, the people there must sit idly by for a quarter of the business day.

Using RMon can also help reduce the number of "emergency" trips to remote sites. By virtue of letting a manager preset performance threshold levels, he or she might be able to spot a problem in the making. This would let a manager take corrective action before the users on the network even notice that anything has happened.

For example, information gathered by an RMon probe might let a manager see that traffic on a LAN segment is increasing at a steady pace and is getting close to the maximum percentage bandwidth utilization that is acceptable before performance noticeably drops. Noting this trend, a manager can segment the LAN so that traffic on each new segment is well below the level where performance suffers.

In this way, the users never see any performance degradation. And a network manager does not receive a call in a few months (when traffic has greatly increased) from screaming users saying it's taking forever for their applications to run.

That's just an example of how RMon will make it easier to automatically collect information about the state of remote networks. This will let managers become more proactive when it comes to keeping their remote sites out of trouble. And with networks becoming increasingly decentralized, network managers will need all the help they can get. ■

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Defining RMon Groups

The IETF specifications for remote monitoring define the following nine feature groups.

Group	Purpose
Statistics	Collects and tracks information about collisions, data rate, and other network parameters.
History	Samples from gathered statistics to build a running history of network performance.
Alarm	Compares network parameters from Statistics Group to preset thresholds to help identify potential problems.
Event	Generates an alarm when a threshold is crossed.
Host	Keeps table of statistics for every MAC (media access control) address.
HostTopN	Prepares tables of hosts, sorted by the value of any statistical parameter gathered over a set period of time (e.g., the hub port through which the most number of packets have passed).
Matrix	Stores statistics.
Filter	Checks packets against manager-defined filters.
Packet Capture	Allows capture of only packets that meet filtering criteria.

Where to Find

NM Elite $2500
(including SMC adapter card)
Comtest International
London, U.K.
+44 171 938 4591
fax: +44 171 938 1649
Blue Bell, PA
(800) 940-1710
(610) 940-1710
fax: (610) 825-7579
Circle 1147 on Inquiry Card.

Notebook Sniffer Analyzer . . . $9995
Network General
Menlo Park, CA
(800) 764-3329
(415) 473-2000
fax: (415) 321-0855
Circle 1148 on Inquiry Card.

OnSite $1875
Arnon Networking
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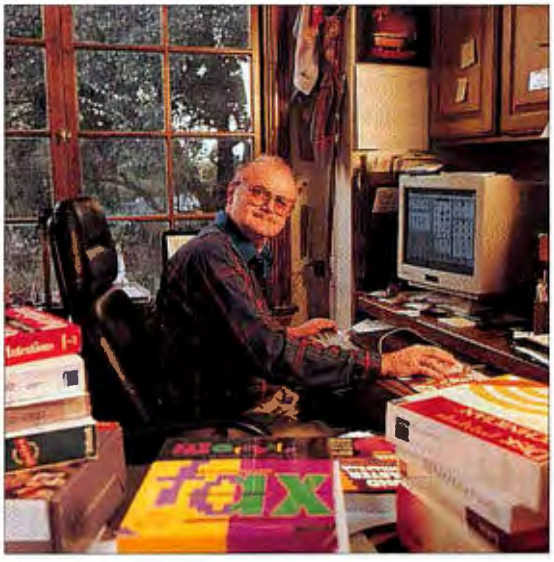
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JERRY POURNELLE

Privacy and Liberty



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Galaxies on the Internet, technological threats to privacy, CD-ROM art exhibitions—the esteemed Dr. Pournelle serves up another technological stew

There's a galaxy called M-87 about 30 million light-years away in the general direction of Cygnus. Observers using the Hubble space telescope are now pretty sure that in that galaxy there is an object weighing something like a billion solar masses compressed into a blob about the size of the end of your thumb. If you have an Internet connection, you can see M-87 and a bunch of other stuff that comes from the repaired Hubble on your computer screen (send E-mail to Holland Ford at Ford@STSCI.edu to find out where you can get more information through the Internet).

I've just been to the annual meeting of the AAAS (American Association for the Advancement of Science). There was a lot of talk about nifty stuff you can find on the Internet, as well as things the Internet lets you do. "Shared minds" and "accidental collaborations" are a couple of them. More on that in a moment.

One of the most heated discussions at AAAS concerned Internet policy and privacy. The principal exchanges were between Dr. Michael Nelson of the White House Office of Science and Technology Policy and Marc Rotenberg of the Electronic Privacy Information Center. The White House policy is that law-enforcement officers must be able to listen in on telephone calls, read fax messages, and record data transmissions. All this would be subject to search warrants, of course; but before they can get a warrant, they have to be able to get at the transmissions.

Rotenberg noted that if this is the era of electronic democracy, it's odd that just after his group delivered a petition from 47,000 people against the Clipper chip, the White House endorsed Clipper. Nelson's answer was, "We pay attention to everyone, not just users."

Clipper, for those of you who may have tuned in late, is a scheme in which a hardware-encryption system would be built into computers. Thus, when you communicate through a computer—E-mail, fax, data transmissions, essentially any communications—there would be automatic encryption at your end and decryption at the other end. Anyone intercepting your messages would be unable to read them.

Anyone but the government, that is. Clipper would have built into it a backdoor key that could be used by the government to decrypt *any* message intercepted. Of course, the government could intercept and decode messages only after obtaining a warrant, and government agencies would keep the backdoor key secure, and everyone can be confident of that, and I am Marie of Romania.

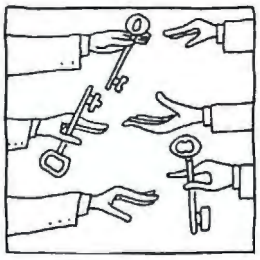
Clipper was supposedly killed last year, but there are periodic attempts to revive it or something like it. There is also pending legislation to provide quite a bit of federal money—up to $500 million—to alter telephone-switching equipment to facilitate government access to telephone, fax, and Internet communications. As Rotenberg put it, they want half a billion bucks to make it easy to wiretap phones.

About then, I began wondering what the argument was about. It seems to me that the cat's out of the bag no matter what they do. Anyone who wants can get PGP (Pretty Good Privacy)—I hope this is the last acronym for the month, but it probably isn't.

PGP is a shareware public-key-encryption

ILLUSTRATIONS: PAUL FISCH © 1995

system worked out by Phil Zimmerman. His system incorporates encryption algorithms developed by RSA Data Security, a Redwood City, California, company. Zimmerman and RSA were in a pretty hefty dispute at one time, but they have settled their differences. RSA sells BSAFE and TIPEM Developer's Toolkits, which can help programmers build systems like PGP.



Public-key systems have two keys: your private key, which you keep, and a public key, which you broadcast to all and sundry. Anyone out there can use your public key to encrypt a message that can be decrypted only by your private key. So long as you keep that key secure, anyone can send you messages that only you can read, just as you can use other people's public keys to send them private messages. Moreover, if you use your private key to encrypt a message, anyone with the public key can decrypt it—and thereby be sure that you sent it. Applications that use the RSA public-key cryptosystem, like PGP, solve the dual problems of privacy and authentication.

PGP isn't easy to use, but Jim Bidzos, president of RSA, says, "Two million Lotus Notes users send 5 million RSA public-key-encrypted messages every day, and most of them don't even know they're using RSA technology. That's how well it's integrated." The Netscape Navigator Internet browser is another tool in widespread use that incorporates RSA's technology as its security engine, and, again, most users don't know they're using it. The cat is truly out of the bag; but the government won't let go.

Zimmerman very carefully did *not* put his PGP system on any BBSes. He did give copies to several friends. One of his friends carefully uploaded it onto local BBSes that were *not* connected to the Internet. Of course, someone then predictably uploaded it to the Internet, and now PGP is available to anyone, anywhere.

This means that no matter what back doors the government puts into the "official" or "authorized" encryption schemes, if you put your message through PGP first, the government isn't going to read it—at least not without considerable effort by the organization generally known as NSA. (That's assuming that Zimmerman hasn't built a back door into PGP, but there are pretty good reasons for assuming that.)

When I pointed this out, Nelson replied that most criminals are pretty stupid, and they won't go to the trouble of using PGP. However, if law-enforcement officers don't have access to the bit stream, there's no possibility of using message interceptions as a tool of law enforcement. There are bad guys out there, and the government has to keep up with them.

Last night, I used the Internet to put that proposition to Jim Warren, who's been around this business as long as I have. His reply was that while some crooks may be stupid, there are a lot of smart ones, and unless we get some standard encryption regularly in use, there's going to be a lot more computer crime—highway robbery on the information superhighway. It's happening already.

This business of the rights of privacy versus the right to have a government strong enough to protect us from criminals and



terrorists isn't easily settled. I expect most BYTE readers start with the same prejudice I have against making it easy for the government to spy on me; but I did want to point out that the government's case isn't trivial, and Nelson makes a pretty strong argument for it. I'll leave it there for the moment, because what I really want to talk about is Zimmerman.

Although Zimmerman didn't put PGP on any BBS, it did get to the Internet, which means that people overseas could call in to the U.S. and download it; and many did. For good or ill, there are laws in the U.S. against exporting cryptographic programs and information. The Justice Department has threatened to charge Zimmerman with violation of those laws. If they manage to convict him, the penalty would be a mandatory 80-month prison sentence. That's nearly seven years, which is about the time actually served by murderers, at least in California.

Zimmerman hasn't been charged; but for a couple of years now, they have threatened to do it, and having an 80-month sentence hanging over your head is a pretty severe punishment all by itself. Because Zimmerman never actually exported the program, my guess is they'll never get a conviction, but that's just a guess—and it's not six-plus years of my life that's at stake.

I asked Nelson why they don't just drop the silly charges. He said that the White House and the president can't get involved. It would be political interference with the Justice Department, and that would be improper. I find that fatuous: it basically says we have rule by a bureaucracy that has no responsibility to the elected officials and through them to the people. However, that appears to be the position of the White House.

I would myself have thought that the Constitution requires the government to bring you to a speedy and public trial, there to be confronted by the witnesses against you; that years of "investigation" is a form of punishment unknown to the law. After all, what's to investigate? There aren't any facts in dispute here.

Nelson was also concerned about precedents.

My suggestion was that this has gone on long enough. If the president thinks he doesn't have the Constitutional authority to tell the Justice Department to either charge Zimmerman or let him alone, I won't argue with him; because the President undoubtedly has the authority to pardon him. It could be a narrow pardon, issued to Zimmerman alone for any alleged violations of

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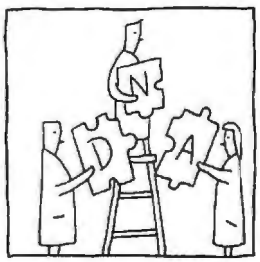
the Export Control laws. That would set no precedents. The Justice Department could charge anyone else with violating those laws; but it would end the persecution of Zimmerman, which has gone on long enough.

If you agree, write the White House. It wouldn't take the White House staff 5 minutes to draft a two-sentence pardon, and the President could sign it in 20 seconds.

Incidentally, I've long pointed out that there are dangers to the free exchange of information. As an example, what happens when you can sequence anthrax at home from a floppy disk? And should we freely exchange the DNA sequence of the smallpox virus once that's available?

Groupware is creating accidental collaborations in the sciences. Dr. James Ostell, chief of the Information Engineering Branch of the National Center for Biotechnology Information of the National Library of Medicine (ostell@ncbi.nim.nih.gov) is charged with taking information generated through government grants and projects and getting it out the door.

The result has been a lot of development tools they distribute for free. While most of these are keyed to biotechnology data, and particularly to searching DNA-sequencing databases, many of the organizing principles used are perfectly general and can be adapted for use by anyone interested in looking through multiple databases. If you're designing that kind of software, you should be aware of what the NCBI is doing.



A recent visitor to the NCBI was looking at inherited resistance to certain parasites in animals and a particular DNA gene sequence that seemed to enhance that resistance. Ostell was showing her how to use his information-search system. They fed in the DNA sequence of interest. Up came hits in the expected animal literature, but then there were two more—in yeasts. Yeasts don't have the kinds of parasites animals do, and animal-parasite researchers generally don't read journals about yeast research. A look at the journal reporting the yeast work showed that the proteins had something to do with cell membranes. It's a lot easier to grow yeast than mice.

Another hit showed the genetic location of the gene in yeasts and an experiment that suggested that the gene controls mechanisms that stop transport across cell boundaries. When his visitor left, she had found the equivalent of a year's work she wouldn't have to do, as well as some strong ideas on what to do next. This whole drama took only about 15 minutes in an office with a computer screen.

Genetic research can be highly competitive. This search software is in the public domain. Query: If you make a discovery through searches of public databases, is that a real discovery for purposes of patent law? I don't think anyone knows how to answer that question. Its twin is: How do you get research people to put their results into these databases? Suppose you make a discovery that seems worthless, but someone else, who has done no biochemical work at all, is able to couple it with two other "worthless" results to make a commercial product?

Of course, groupware can be used in fields far removed from biochemistry and genetic engineering. We haven't got even

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a small start on the legal problems these accidental collaborations are going to pose.

I went from Atlanta to Washington before getting back home. I'm due to go back there shortly. They want me to testify to the House Science and Astronautics Committee about the future of space flight and, in particular, low-cost access to space. I know from my mail that a lot of you are interested in this, and I'll have more information when things settle in.

I used the trip to give Gateway 2000's Liberty notebook a thorough test. As I usually do, I carried two machines, Liberty and Zenith's Z-Noteflex, because I must have a working system, and Zenith laptops are highly reliable.

So, I find, is Liberty. It weighs only 4.2 pounds and is easy to use on an airplane. The 78-key keyboard is usable, although I would not have thought so from my first inspection. The keys are all jammed up close together near the hinge of the computer, leaving empty space down below where there would be a trackball, except there is no trackball. I'll get to the pointing device in a bit. The Return key looks too small, the Backspace key is in the wrong place, the Control key is down at the bottom and can't be switched with the stupid Caps Lock, the Tab is little bitty—all features I hate in a keyboard. On the gripping hand, Liberty is a *light* machine, and I really and truly wanted something I could carry around with me.

The upshot was that I wrote several thousand words with Liberty on an airplane seat tray and was able to meet a deadline. All that empty space at the bottom of the keyboard is just great as a wrist rest. I hate writing on airplanes, but I had no choice, and using Liberty I was able to pound out the words. That, however, was first-draft work using Q&A Write, a DOS program running under Windows.

The acid test was final-editing a complex book, requiring footnotes, endnotes, and comments, as well as rewrites of many paragraphs and insertion of new material. This required Microsoft Word 6.0c, which is a hairy program inclined to be slow on older laptops—it brought one of our Hewlett-Packard laptops to its knees—so I was prepared for the worst. Instead, Liberty worked splendidly. My saves were speedy, and I always do a full save with backup, not the Fastsave option. The Liberty I have uses a 100-MHz 486DX4, and it's plenty fast.

Liberty uses an odd pointing device: a gizmo like a pencil eraser head up where the Backspace key ought to be, with the "mouse buttons" down just below and to the right of the space bar. Right-handers will use the EZ Point integrated pointer with a finger and whack the buttons with the thumb. That takes getting used to, and you sure want to adjust the mouse speed and acceleration in the Windows control panel. After an hour, I was able to use it, and in another hour, I found I actually preferred EZ Point to a thumbball. Of course, I'm right-handed; I don't know how a left-handed mouse user would even get started.

I know there are those who don't like the Liberty's "mouse"—one friend calls it dorky—but I find I can use it just fine.

I do wish they had put a second blue Fn key on the right side of the keyboard; although there are non-Fn PageUp and PageDown keys, End and Home require Fn-arrow, and that requires two hands. That, however, is about the only thing I would do to that keyboard. Because I am very picky about keyboards, that astonished me, so I did a bit of self-analysis.

My conclusion is that I still prefer big keyboards with lots of keys laid out just the way I want them; but I use notebooks



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in such cramped and generally uncomfortable places that I don't expect things to be just right, so I put up with more. Whatever the reason, I like the Liberty keyboard just fine.

Liberty also has a *big* (10.4-inch) color screen. In fact, it's larger than the Z-Noteflex's screen and about as big as any laptop screen I know. It's bright and clear and very easy for me to see at laptop distances in nearly any light. Nothing is going to make writing and editing on airplanes much of a pleasure, but Liberty took a lot of the sting out of it.

There's no floppy drive on Liberty; if you want a floppy disk backup copy of your work, you attach a rather small external floppy drive to the parallel port. It can be done at any time, and it will work on battery power, provided you don't wait until the battery is really low.

Liberty's battery life is about 3½ hours with hard usage. By hard, I mean that I saved to the hard disk after every footnote and every major paragraph, and I hardly gave the machine any rest at all; and I got 3½ hours of work done on each leg of the trip. Here at home, I can get longer than 4 hours, but that's not with hard use. I think 3½ hours is an honest estimate of what you'll get on the road.

Liberty's batteries are fairly small, and you can easily carry an extra one in your briefcase. I've experimented with changing on the fly. Liberty doesn't exactly turn off; if you hit the off switch, it goes into a deep sleep that it recovers from only when you hit that switch again. When it does, it's right back where you were when you turned it off. This is as opposed to the light sleep that happens when you don't hit a key for a while; the screen goes dark, but striking any key wakes it up again. Anyway, if you turn Liberty off and quickly change batteries while it's in deep sleep, nothing gets lost. I've tried that a few times and I believe it, although I'll still save before I do it.

Liberty has two PCMCIA Type II slots (or one double-thickness slot, if you choose to use it that way). I've got a Megahertz 14,400 PCMCIA Data/Fax Modem with XJack in one of them, and it works just fine with Procomm 2 in a DOS window (I know I'm old-fashioned, but that's the program I use) and WinFax. The Megahertz card has a gizmo that lets you connect to an ordinary phone line; no special cable is needed. The connection is more secure than the cable connection to the Data Race RediCard RC-1496 Data/Fax Modem in my Z-Noteflex. I haven't noticed much difference in communications capabilities between the Megahertz and Data Race products. Both appear to be good enough.

All told, then, Liberty is a real joy, the first lightweight portable I'd contemplate carrying as my only machine on the road. Provided that you get used to the pointing device, I think you'll like it. I sure do. Recommended.

Everyone's trying to enter the mouse business, either to make a better mouse or to replace mice. Logitech not only has trackballs but cordless mice, which work quite well, as do their normal mice. And Microsoft has gone beyond the "Dove soap bar" (Home Mouse) to its "Big Teardrop" (Mouse 2.0), another good standard mouse. But the big tendency is to use something else.

Lexmark—a spin-off company that used to be the IBM Information Products Division—has a Classic Touch line of keyboards. They're the genuine IBM loud clickers that use Lexmark's buckling-spring technology. You can also get Lexmark keyboards with quieter keys using rubber-dome technology (e.g., Quiet Touch, Easy Touch, Streamlined, and Thinlined keyboards). Me, I have always liked the sound and feel of those IBM loud clickers.

Lexmark keyboards mostly have the 101-key layout, with the function keys across the top of the board; an island, with the arrow keys in an inverted T pattern; the six special keys (e.g., Insert, Home, and PageUp) in a block above the arrow keys; and a numeric keypad off on the right.

Some of these keyboards incorporate pointing devices. There's one with a trackball in the upper right corner, called the Classic Touch with 25-mm Trackball. Another, the Classic Touch with Integrated Pointing Stick, has an eraser-head "mouse" just above the B key; the button keys are down below the space bar. This is similar to the device on IBM ThinkPad laptops, and it operates much the same as Liberty's eraser head.

There's also a weird one, the Select-Ease. It's split down the middle and pivots at the top, so that you can have your hands at what they think is a natural angle. (The Select-Ease comes standard with an extended numeric keypad.) This is similar to the Microsoft Natural Keyboard, except that with the Microsoft keyboard you have no choices, except height adjustment. The Select-Ease can be turned back into a normal keyboard or spread at a really odd angle if you'd prefer that.

Most of these keyboards (including the Select-Ease) come with what Lexmark calls the Erase-Eaze option. What that

means is that the space bar is split in half, and you can program half of it—normally the part struck by the left thumb—as the Backspace key. This neatly solves the problem created by putting the real Backspace key in the wrong place, up on the row with the numbers instead of next to the P key, where it belongs (and where it was on IBM Selectric typewriters).

The thing about Erase-Eaze is that if you've been typing for very long, you'll really hate it. Niven somehow acquired an Erase-Eaze keyboard, and not realizing that you could program it so that it didn't have that feature, he donated it to a school to get it out of his house. Incidentally, he's quite happy with the Microsoft weird-hump keyboard, and that's the one I have on his machine when we work together at Chaos Manor.

Of these Lexmark keyboards, the one that intrigues me most is the Classic Touch with Integrated Pointing Stick without the Erase-Eaze option. It doesn't take all that long to learn how to use the pointing stick, and once you do, it's sure a lot easier than reaching over to grab a mouse. Having said that, I'll confess that I am still using my Northgate Computer Systems' OmniKey Plus keyboard and a Microsoft New Mouse, but that's in part because I like function keys along the side rather than on top, and my keyboard has the Backspace key next to the P.

One of these days, though, my OmniKey Plus will finally wear out, and when it does, I may well go over to the Lexmark Classic Touch with Integrated Pointing Stick. I've used it several times now, and I like it a lot.

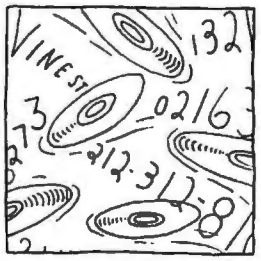
Keyboards are very personal things. Because I spend a lot of time pounding on one, I tend to be pretty fussy about the one I use. If you do a lot of writing, check out the Lexmark keyboards. You may love one of them.

Yet another pointing device is the GlidePoint from Cirque; it's a fingerpad. It sat here unopened for about a month because five years ago I tried mushpad pointing devices and hated them; but Roberta's Power Mac has one, so I thought what the heck.

Connecting up the GlidePoint required unplugging the Microsoft mouse, plugging in the GlidePoint, and resetting the machine. It worked first thing. I've since tried it on other machines with similar results. The machine believes it has a Microsoft mouse.

The GlidePoint is 2½ inches tall by 3½ inches wide; a bezel reduces the actual mushpad surface to 2¼ by 1½ inches. To use it, just put your finger on it and move it around. The cursor follows quite nicely. There are two buttons at the bottom of the GlidePoint, and they work as expected. It's pretty easy to activate them with your thumb.

Most interesting, though, is that you can tap the surface of the mushpad to get the same result as a single click of the left mouse button, and a double-tap acts like a double-click. This works quite naturally and takes no getting used to.



What does take getting used to is click and drag, where you click and hold with your thumb and then drag with your finger. It's not all that hard to do, but it's not as natural as clicking and dragging with a mouse, and I haven't yet become comfortable with it. I sure am with everything else though, and I'm strongly tempted to change over just to see if it improves productivity. Alex used it to play Master of Orion last night and found it quite satisfactory for that. I haven't tried it with Doom yet.

Fair warning, some people, including a couple of BYTE editors, really hate this thing. Others like it. Like all personal equipment, you have to take a view about this. In any event, the GlidePoint is a serious contender as a pointing device, and, if you're sick of rodents, you might want to look into it. It works.

About half the time I don't spend pounding on a keyboard seems to be spent on the telephone. Often I need to do both, particularly when I'm trying to get technical support and I'm on hold waiting for "the next available" person. While there's no remedy for being put on hold, there is a way to keep on working while it happens: use a Plantronics Super Headset with M10 Adapter. Not only does that leave both hands free, but I can listen to my classical music station while I continue to type away. There's a volume control in the adapter, and if I turn that all the way up, I'm sure to hear when someone comes on the line.

Once you do reach someone in technical support, it's very useful to have both hands free while discussing the problem, particularly if the difficulty is hardware. The Super Headset comes on a long cord—it doesn't start to pull uncomfortably until I'm about 10 feet from the instrument—and attaches to the side of my phone with Velcro, so that I can move the phone across the room and then get 10 feet from that. The result is that I can get to almost any machine in the office. I also do radio interviews by phone when I'm trying to get publicity for a book, or for the space program, and it's pretty convenient to have a headset for that.

The adapter has settings to let it work with just about every kind of phone. We have a TIE six-line system, and that gives it no problems. Installation is simple: the adapter plugs in where the handset went and then the handset and headset plug into the adapter. Plantronics sells a little hook-like gizmo that you can hang the headset from. Without that, it's somewhat awkward finding a place to keep the headset when it's not in use. Other than that, I've had no problems.

I've found that sometimes I use a gadget for a while and then get tired of it. I've had this Super Headset for several months now, and I use it more now than when I first got it. If you spend much time on the phone, you may well want one. Recommended.

PhoneDisc '95 PowerFinder is actually five CD-ROMs that contain just about all the private and business phone numbers, as well as addresses with ZIP codes, in the country. It doesn't list addresses for unlisted telephone numbers, but it sure lists a lot of names and addresses. I found people I haven't thought about for years.

It's remarkably easy to use. Insert the CD-ROM and run phone disk (from File Manager, DOS, or Norton Commander) directly from the CD-ROM. You can also install it on a Mac. Then search by name, business type, or city and street address. The business types are by occupation code numbers, but that doesn't turn out to be a problem. Just browse. The response in Windows is nearly instantaneous on my Cheetah 66-MHz 486DX. Because it's a DOS program, you can do Alt-Enter to mark and paste.

If you can use a computer at all, you can use this. Just spend 10 minutes fooling around with it, and you'll learn it. Highly recommended.

If you get the Discovery Channel, you know it does a great job on documentaries. Now there's a series of multimedia CD-ROMs based on those documentaries. There's one on space (Beyond Planet Earth), another on whales (In the Company of Whales), and another on sharks (Sharks). They're all pretty good, but I'd rather watch the Discovery Channel.

The CD-ROMs have some material that's probably not in the TV shows, and,

For More Information

A series of multimedia CD-ROMs based on Discovery Channel documentaries, **Beyond Planet Earth, In the Company of Whales,** and **Sharks** ($49.95 each) are all pretty good. Contact **Discovery Communications, Inc.,** Bethesda, MD, (800) 762-2189 or (301) 986-1999. **Circle 1151 on Inquiry Card.**

The **BSAFE Developer's Toolkit** and **TIPEM Developer's Toolkit** ($290 each) can help programmers build systems like PGP. Contact **RSA Data Security, Inc.,** Redwood City, CA, (800) 782-5453 or (415) 595-8782; E-mail: info@rsa.com. **Circle 1152.**

If you do a lot of writing, check out the Lexmark **Classic Touch Keyboard** ($99; with Erase-Eaze option, $104), **Classic Touch with 25-mm Trackball** ($129; with Erase-Eaze option, $134), **Classic Touch with Integrated Pointing Stick** ($129), or **Select-Ease** ($179). Contact **Lexmark International, Inc.,** Greenwich, CT, (800) 438-2468 or (606) 232-2000. **Circle 1153.**

GlidePoint ($89) is a serious contender as a pointing device, and if you're sick of rodents, you might want to look into it. It works. Contact **Cirque Corp.,** Salt Lake City, UT, (800) 454-3375 or (801) 467-1100; E-mail: cirque @xmission.com. **Circle 1154.**

Liberty ($2799 to $4499) is the first lightweight portable I'd contemplate carrying as my only machine on the road. Contact **Gateway 2000, Inc.,** North Sioux City, SD, (800) 846-5257 or (605) 232-2000. **Circle 1155.**

A Passion For Art: Renoir, Cezanne, Matisse, and Dr. Barnes ($49.95) is the first CD-ROM I've seen from this company, and it's really neat. Contact **Corbis Publishing,** Bellevue, WA, (206) 562-6000. **Circle 1156.**

I've got a Megahertz 14,400 **PCMCIA Data/Fax Modem with XJack** ($249) in one of Liberty's PCMCIA Type II slots, and it works just fine with Procomm 2. Contact **Megahertz Corp.,** Salt Lake City, UT, (800) 527-8677 or (801) 320-7000. **Circle 1157.**

PhoneDisc '95 PowerFinder (with one free update, $249) is actually five CD-ROMs that contain just about all the private and business phone numbers, as well as addresses with ZIP codes, in the country. Contact **Digital Directory Assistance, Inc.,** Marblehead, MA, (800) 284-8353 or (617) 639-2900. **Circle 1158.**

I've had a **Super Headset with M10 Adapter** ($186) for several months now, and I use it more now than when I first got it. Contact **Plantronics,** Santa Cruz, CA, (800) 544-4660 or (408) 426-5858; E-mail: 74357.234 @compuserve.com. **Circle 1159.**

of course, you can go over it more than once—in fact, you will, because some of the multimedia presentations are given several times. There are also four experts, talking heads who each answer the same questions. In the space CD-ROM, the experts include Buzz Aldrin, second man on the moon. Buzz is always interesting, but I'd as soon watch him on the Discovery Channel rather than as a 2-inch-square talking head on my computer screen. For that matter, I'd as soon read what he has to say in *Discovery* magazine, where I'd also get a lot more pictures.

On the other hand, there are some good motion pictures, and In the Company of Whales has recordings of whale songs; if you've never heard whales sing, nothing in print is going to describe it for you. On the gripping hand, you can read the magazines and watch the TV shows—rent the tapes if you don't get the Discovery Channel—and get all that's on the CD-ROM and more.

I suppose I'm getting jaded. A few years ago, I'd have been thrilled to have CD-ROMs on science at junior high level, especially multimedia as well done as these. As it is, I can recommend them for science clubs or school libraries, but I doubt anyone will spend more than a couple of hours with any one of these.

In contrast to the Discovery CD-ROMs, A Passion for Art: Renoir, Cezanne, Matisse, and Dr. Barnes doesn't give you talking heads. Instead, there's a rapid-fire series of stills with a voice-over by a breathless announcer right out of the old newsreels to tell the story of the Barnes Foundation. I had never heard of it before, and it's fascinating.

There's a walk through the gallery, and you can zoom in to paintings and sculptures from Dr. Albert C. Barnes' private collection of impressionist and Postimpressionist paintings. There are lots of comments and details concerning what modern art is about and why it inspired such devotion; and all this is done very smoothly.

This CD-ROM didn't start as a magazine or a videotape, and that shows. It does things only a CD-ROM can do. Moreover, when you do get tired of the CD-ROM presentation, there's software to let you build your own slide show.

Corbis Publishing buys up nonexclusive rights to artistic and educational artworks—images, sounds, and anything else they think they can use—and makes interactive multimedia presentations from them. This is the first I've seen from the company, and it's really neat. I'm going to keep this one.

My mention of *The Bell Curve: The Reshaping of American Life by Differences in Intelligence* by Charles Murray and Richard J. Herrnstein (see my February column) brought a lot of mail. Some of it was astonishingly intemperate, considering how little I said; my guess is that several of the professors who wrote in such hot tones had read only one chapter of the book. Much of the controversy over *The Bell Curve* is concentrated on a chapter that I didn't mention and isn't central to the book's thesis.

We may all wish that we lived in Lake Wobegon, but we don't. *The Bell Curve* forces you to consider that half the people in this nation are below average in intelligence; and while that might not have been so important in the past, it has implications for a merit society in the information age. Some of those implications involve public policy. You needn't accept the recommendations that are made by Murray and Herrnstein (although I'd be astonished if some of those who wrote me had any inkling at all of what those recommendations are), but you won't escape the implications by not thinking about them.

One possible policy is to assign people to jobs strictly on the basis of merit. The problem is that if you're to have full employment, you need to have jobs for everyone. And it's no more certain that assigning "the best person to each job" is the most overall efficient way than that the best solution to the classic traveling-salesman problem is for him to go to the closest town at each decision point. In fact, personnel managers have for a long time known that the "assignment problem" in which you must place everyone who applies is mathematically analogous to the traveling-salesman problem; and that generally is considered to be in the domain of computer science.

Enough on that. By next week, I'll have all my space program papers finished, and I promise not to mention policy wonking for at least two months. ■

Jerry Pournelle holds a doctorate in psychology and is a science fiction writer who also earns a comfortable living writing about computers present and future. Jerry welcomes readers' comments and opinions. Send a self-addressed, stamped envelope to Jerry Pournelle, c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Please put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply. You can also contact him on the Internet or BIX at jerryp@bix.com.



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What's New Hardware



Wireless Infrared Printing

The LaserJet 5P and 5MP printers include an infrared port for wireless printing from portable PCs and PDAs. The devices offer 6-ppm print speeds, flexible paper-handling capabilities, 600- by 600-dpi output, expandability, and font management software. The LaserJet 5P and 5MP printers also come with SIMM slots that you can use for additional memory, other printer languages, and customizing options. The LaserJet 5P ($1109) is expandable to 50 MB, and the LaserJet 5MP ($1299) is expandable to 35 MB.

Contact: Hewlett-Packard, Santa Clara, CA, (800) 752-0900 or (208) 323-2551; E-mail: http:\\www.hp.com.

Circle 1322 on Inquiry Card.

Scalable Multiprotocol WAN Server

For data-communications service providers expanding their networks, the Multi-Protocol WANServer 3000 (base unit, which includes a rack-mountable 16-port Interface Distribution Module and SBus Host Interface Card, $3500; additional 16 ports, $2800) provides up to 64 high-speed WAN access ports for integration into SPARC system–based data switches, network servers, and multiline data- and voice-delivery systems. Every port is independently configurable and has the ability to support data transfer rates of up to 256 Kbps full-duplex per line; software-selectable electrical interfaces, including RS-232, RS-422, RS-449, RS-485, RS-530, and V.35; and synchronous and asynchronous transmission.

Contact: Aurora Technologies, Waltham, MA, (617) 290-4800; E-mail: info@auratek.com.

Circle 1343 on Inquiry Card.

Modem/Fax/LAN Combo PC Card

WinMax contains a 19.2-Kbps "soft" data modem, a fax card, and an Ethernet LAN interface adapter for 10Base-T LANs, all in one PCMCIA package (modem/LAN combo, $249; modem/fax only [V.32 terbo], $129; LAN interface only, $99). The software-driven modem maximizes data throughput by using the power of the PC to perform data compression and error protection and to issue the commands to instruct the AT&T data-pump chips to perform modem functions. Large buffers in the modem let you transfer hundreds of characters during a single interrupt, drastically reducing the computer's processing load.

Contact: Data Race, San Antonio, TX, (800) 329-7223 or (210) 558-1900; E-mail: bdavis@datarace.com.

Circle 1325 on Inquiry Card.



SPARC-5-Compatible ▲ Workstation

Powered by an 85-MHz MicroSparc II chip, the entry-level configuration of the microCompstation 5/85 RISC system (less than $4000) comes with an SVGA/CG3 frame buffer, a 14-inch color monitor, 16 MB of memory, a 520-MB hard drive, two serial ports, one parallel port, and three SBus expansion slots. The system also includes built-in 16-bit audio capabilities and such components as internal speakers and audio ports. Options include 15-, 17-, and 20-inch color monitors; up to 256 MB of memory; up to a 4-GB hard drive; and a Turbo GX or Turbo GX+ graphics accelerator.

Contact: Tatung Science & Technology, Milpitas, CA, (800) 659-5902 or (408) 383-0988; E-mail: annie@tsti.com.

Circle 1333 on Inquiry Card.

Computer Telephony Appliance

The components of the QuadraFax fax and voice processing system (two-port systems, from $2995; four-port systems, from $3995) are the system unit and the administration software. The system unit sends and receives faxes, records and plays back voice prompts and messages, detects and interprets DTMF signals, and performs adaptive call progress. The administration software creates voice files for prompts and responses from desktop sound systems, and it configures the system with dialing instructions and other telephone functions.

Contact: Brooktrout Technology, Needham, MA, (800) 333-5274 or (617) 449-4100; E-mail: info@brooktrout.com.

Circle 1340 on Inquiry Card.

Multimedia Kit

The Diamond Multimedia Kit 6000 ($399) combines an IDE quad-speed CD-ROM drive, a 16-bit stereo-quality sound card, speakers, automatic installation software, and six finance and office-productivity applications. The CD-ROM drive provides a 600-KBps transfer rate, an access time of 230 ms, and a buffer size of 128 KB.

Contact: Diamond Multimedia Systems, San Jose, CA, (800) 468-5846 or (408) 325-7000.

Circle 1327 on Inquiry Card.



Upgrade Your DDS ▲ Tape Drives

The MiniChanger 400 Series of auto-loaders includes two different models. The MC400S ($2995) combines TapeWorks' robotic tape-cartridge-loader mechanism with a DDS-2 tape drive, which provides a 64-GB tape backup storage system, and a six-tape Flat-Pak magazine with DDS-2 media and a SCSI-2 connector cable. The MC400U upgrade product ($1595) includes TapeWorks' robotic mechanism without a tape drive, a six-tape Flat-Pak magazine without media, and a SCSI-2 connector cable.

Contact: TapeWorks, Fort Collins, CO, (800) 704-1997 or (303) 224-1709; E-mail: cse@tapeworks.com.

Circle 1326 on Inquiry Card.

LAN-CABLE TESTER

A portable LAN-cable tester, the LANtek Pro XL ($4495) grades the reliability of network cabling by testing line mapping, Dual Next, signal attenuation, DC loop resistance, mutual capacitance, cable length, and attenuation to cross-talk radio. In addition to testing Ethernet and Token Ring network frequencies, the LANtek Pro XL tests attenuation and two-way Next to 100 MHz. In addition, you can store your test results in the LANtek Pro XL's internal memory, download them to a PC, or print them. With the optional Fiber-Kit ($895), the LANtek Pro XL can display optical power loss through fiber cable, splices, and connectors.



Contact: Wavetek, San Diego, CA, (800) 854-2708 or (619) 279-2200; E-mail: madaras@wavetek.com.

Circle 1132 on Inquiry Card.

CONTROL GPIB INSTRUMENTS WITH YOUR MAC

With the GPIB-232CT-A/Mac, an external RS-232-to-GPIB controller, you can control GPIB instruments from your Mac's printer/modem port. The device ($595) implements a normal and extended Talker and Listener, serial and parallel polling, service requests, pass- and receive-control functions, and remote-programming functions.

Contact: National Instruments, Austin, TX, (800) 433-3488 or (512) 794-0100; E-mail: info@natinst.com.

Circle 1331 on Inquiry Card.

30-INCH TRINITRON MONITOR

A high-resolution monitor with a 16-to-9 aspect ratio, the GWM-3000 ($21,900) incorporates a 30-inch Trinitron tube with a 28-inch-diagonal viewing area and noninterlaced resolution of 1920 dots by 1080 lines, or more than 2 million pixels. The monitor can display characters as small as 0.1 inch high from corner to corner anywhere on the screen. Digital Alignment technology allows precise display adjustments; Auto Calibration optimizes user-selected color balance.

Contact: Sony Component and Computer Products Group, San Jose, CA, (800) 352-7669 or (408) 432-0190.

Circle 1133 on Inquiry Card.

PCI SCSI ADAPTER

The ABP940 SCSI host adapter connects up to seven drives to a single PCI slot in PCs, workstations, and servers. The plug-and-play adapter ($379) comes with the AdvanSys universal SCSI software driver, which replaces up to seven software drivers in a single computer.

Contact: AdvanSys, San Jose, CA, (800) 525-7443 or (408) 383-9400; E-mail: louw@advansys.com.

Circle 1342 on Inquiry Card.

ISDN REMOTE-LAN ACCESS

KNX's three ISDN remote-LAN-access products include the KNX Access Server Basic, or ASB; the KNX Access Server as an NLM, or AS-NLM; and the KNX Remote LAN Workstation, or RLW. The ASB ($1595; expansion kit, $795) provides remote access to the corporate network across ISDN. The AS-NLM ($1195; expansion kit, $795) allows remote access from Novell NetWare file servers and provides ISDN support for third-party applications. The RLW ($795; analog telephone interface, $200), designed for a single-user/single-device environment, lets you remotely connect to corporate LANs to access files, mail, or databases or to obtain embedded access in point-of-sale equipment or credit-card authorization.

Contact: KNX, San Francisco, CA, (800) 569-5267 or (415) 764-1700.

Circle 1330 on Inquiry Card.



MULTIMEDIA KEYBOARDS ▲

The Platinum Sound Multimedia Audio and Stereo Keyboard is available in two different models. The MAK-100 Multimedia Audio Keyboard ($129.95) features a built-in omnidirectional microphone; 4-inch magnetically shielded, 16-W, full-audio-range speakers; external microphone and headphone jacks; and a volume-control knob. In addition to the features of the MAK-100 Keyboard, the MSK-200 Multimedia Stereo Keyboard ($229.95) provides separate volume, bass, treble, and balance controls using soft sliding controls with center positions.

Contact: SC&T International, Phoenix, AZ, (800) 408-4084 or (602) 470-1334.

Circle 1338 on Inquiry Card.

ANALOG SIGNAL-CONDITIONING MODULES

The 5B isolated analog signal-conditioning modules ($150 to $205) are for frequency input, voltage output, four-wire RTD input, resistive input, narrow-bandwidth strain-gauge input, two-wire transmitter interfacing, and servo/motor control.

Contact: Intelligent Instrumentation, Tucson, AZ, (800) 685-9911 or (602) 573-0887.

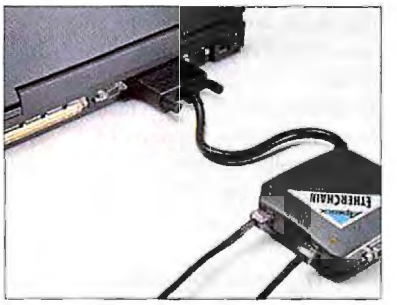
Circle 1328 on Inquiry Card.

DISPLAY FOR SPARC WORKSTATIONS SAVES SPACE

Weighing only 17½ pounds, the Integrix subsystem for SPARC-based workstations includes the 13-inch N209 true-color flat-panel display, which offers a resolution of 1280 by 1024 pixels, a refresh rate of 60 Hz, and display of 256 colors from a palette of 16.7 million. Also included are a TGX125 graphics accelerator card with 2 MB of video memory, 1.7 million 2-D vectors per second, and 560,000 3-D vps; and a six-foot cable. Cost for the subsystem is $16,995; sold separately, the TGX125 card costs $1995.

Contact: Integrix, Newbury Park, CA, (800) 300-8288 or (805) 375-1055; E-mail: sales@integrix.com.

Circle 1332 on Inquiry Card.



ETHERNET ADAPTER ▲ FOR PORTABLES

The EtherChain Network Adapter lets you connect laptop PCs anywhere on a 10Base-T Ethernet network. You simply connect the adapter ($349) to a PC's parallel port and daisy-chain the PC into the network at any point. The printer port pass-through lets you continue printing automatically to your local printer.

Contact: Apexx Technology, Boise, ID, (800) 767-4858 or (208) 336-9400; E-mail: 71043.2403@compuserve.com.

Circle 1137 on Inquiry Card.

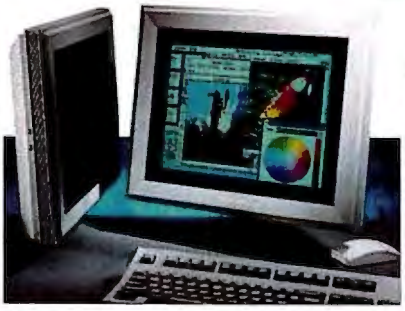
What's New Hardware

MULTIPLATFORM PRINTER SERVER

Designed for Ethernet networks, NetQue Mate ($399) allows users to share one printer or plotter from up to 30 different operating environments, including Microsoft LAN Manager, Novell NetWare, IBM LAN Server, Apple EtherTalk, Windows NT, and Unix TCP/IP.

Contact: Emulex, Costa Mesa, CA, (800) 854-7112 or (714) 662-5600; E-mail: literature@emulex.com.

Circle 1334 on Inquiry Card.



FLAT-PANEL COLOR MONITOR ▲

The Model 460 ($7950; with options, $8995) flat-panel color monitor is a 14.2-inch active-matrix display that is only 3 inches deep. The screen supports 16.7 million colors for precise color presentations and offers optional touchscreen and video capabilities.

Contact: PixelVision, Acton, MA, (508) 264-9443.

Circle 1344 on Inquiry Card.

MULTIMEDIA MODULE FOR PCS

The PDQ Mobile Multi-Media Module, or M4, lets you play audio and multimedia CDs on most notebook and desktop PCs via the parallel port. A self-contained unit, the PDQ M4 ($149) contains a power supply and a multifunction PCB that provides a Sound Blaster–compatible sound controller and SCSI, IDE, speaker, microphone, and printer pass-through ports. The volume control is software programmable and supports 16-bit mono and stereo sound at up to 44 kHz.

Contact: PDQ Peripherals, Santa Clara, CA, (800) 737-7462 or (408) 727-2600; E-mail: pdqperiph@aol.com.

Circle 1335 on Inquiry Card.

INTERNAL SURGE SUPPRESSOR

Designed for installation inside your PC, the Defender/OVP ($39.95) protects your PC's voltage-sensitive hardware components against damage caused by lightning, power-line surges, switching artifacts, static discharge, and power-supply failures. Upon detection of an overvoltage condition, the Defender/OVP shuts down the power supply's outputs, in effect turning the computer off and protecting it from damage.

Contact: IsoBlock, Decatur, GA, (404) 325-8282.

Circle 1336 on Inquiry Card.

NETWORK FAXING

FaxPress 3000 lets LAN and enterprise-wide network users send and receive faxes directly from their workstations. The self-contained server features increased processor speed; concurrent support for four outgoing lines at 14.4 Kbps; 10Base-T/BNC with auto-selection; and 1 MB of memory, upgradable to 8 MB. The FaxPress 3000 is available for Ethernet (two-line version, $3995; four-line version, $4795) and Token Ring (two-line version, $4295; four-line version, $4995) LANs.

Contact: Castelle, Santa Clara, CA, (800) 289-7555 or (408) 496-0474; E-mail: sales@castelle.com.

Circle 1337 on Inquiry Card.

DIRECT-INWARD-DIALING NETWORK FAX-SERVER BOARD

Faxination DID routes incoming faxes from the fax server, through the LAN, and directly to users' workstations. Operating at a 14.4-Kbps V.17 fax-transmission rate and using Modified Read data compression, Faxination DID (two-port version, US$1845; four-port version, US$3245) supports T.30 subaddress routing and provides automatic trunk-busy out, trunk-loop back test, diagnostic tools, power-fail support, and DTMF and pulse-dial decoding.

Contact: PureData, Richmond Hill, Ontario, Canada, (905) 731-6444; E-mail: stephen-lwan@puredata.com.

Circle 1339 on Inquiry Card.

ENTERPRISE-WIDE TAPE BACKUP

The DLT20 is a digital linear tape drive that uses half-inch cartridge streaming tape in a 5¼-inch full-height case. The drive ($2999.95; data and cleaning cartridges, $45.95 each) can pack up to 20 GB of data on a DLT CompacTape II data cartridge and feeds data at rates of up to 110 MB per minute.

Contact: APS Technologies, Kansas City, MO, (800) 235-2753 or (816) 483-6100; E-mail: sales@apstech.com.

Circle 1341 on Inquiry Card.

AMPLIFIER/SPEAKER PACKAGE ▶



The TC 1490SP package consists of a high-power/zero-footprint amplifier and a pair of high-output speakers that enhance the audio performance of most PC- or Mac-based multimedia systems. The package ($249.95) includes a 40-watt-per-channel integrated amplifier, two SP 510 speakers, a five-band graphic equalizer, an LED level meter, and tone-defeat control. The built-in FET microphone and variable microphone-mixing circuitry enable you to use the package with voice-recognition software.

Contact: Micro Multimedia Labs, Reisterstown, MD, (410) 429-4300.

Circle 1329 on Inquiry Card.

NETWORK-TRANSPARENT GREEN PCS

Two Energy Star–compliant PCs, the Preferred 5/100E PCI ESP (from $2998) and the Preferred 5/100 PCI ESP (from $2792) are based on the Intel 100-MHz Pentium P54C processor. A network-activity-detection algorithm allows the systems to sleep and reawaken while maintaining connection to the host network. The Preferred 5/100E PCI ESP supports EISA, ISA, and PCI. Available in desktop or tower configurations, the systems come with 8 MB of RAM, at least 256 KB of high-speed Level 2 modular cache memory, a 420-MB hard drive, a 3½-inch floppy drive, a 1-MB VGA board, a 15-inch VGA monitor, and a 101-key keyboard.



Contact: CSS Laboratories, Irvine, CA, (714) 852-8161.

Circle 1324 on Inquiry Card.

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MOCK TURTLENECK.
Outer Banks 100% cotton mock turtleneck with 20th Anniversary logo embroidered on left chest. White. Sizes: M-XL. M-BYT 4, L-BYT 5, XL-BYT 6. $25.85.



CERAMIC MUG.
11 oz. ceramic mug with gold band and 3-color, 2-sided logo. BYT 8. $4.50.



MOUSE PAD.
Hard top mouse pad. 4-color with 20th anniversary logo and tag line and repeating text background. 7.5" x 8.5" x 3/16". BYT 7. $5.25.



SWEATSHIRT.
11 oz. cross grain Lee sweatshirt with 20th Anniversary logo embroidered on left chest, features generous athletic cut and side gussets. 95% cotton, 5% polyester. Ash. Sizes: M-XL. M-BYT 1, L-BYT 2, XL-BYT 3. $31.20.



BALL CAP.
Soft brushed cotton free-form ball cap with adjustable Velcro closure back and 20th Anniversary logo embroidered on front. Black. BYT 11. $14.75.



PARKER VECTOR PEN.
Parker Vector Sport Roller Ball Pen. Black with 3-color BYTE logo repeated on barrel and cap. BYT 10. $6.25.

PARKER PEN.
Parker Insignia ball point pen. Laque black with 3-color BYTE logo on clip emblem. BYT 9. $34.50.



T-SHIRT.
100% Cotton Oneita Power-T. White with 1-color "technology" print on both sides and 4-color 20th anniversary logo on front. Sizes: L-XL. L-BYT 13, XL-BYT 14. $8.00.

COMPUTER TOOL KIT.
Deluxe computer service tool kit in black vinyl zipper case features: 2 nut drivers, 3 prong ports retriever, tweezers, torx driver, IC Extractor, one Phillips and 2 slotted screwdrivers. 1-color 20th Anniversary logo. BYT 12. $20.10.



Ordering: Credit card phone orders: Call 1-800-676-HALO (4256) (in IL, call 708/647-4902). We accept VISA, MasterCard, American Express and Discover. Merchandise in stock will ship within 2-3 business days of receipt. If an item is out of stock, the customer will be notified and given the option to backorder, substitute or cancel the item. Rush orders can be shipped the same day received if the order is placed by 2:00 p.m. CST. Rush orders will incur a $10 additional charge and express freight charges will be billed at cost.

Shipping: Include the following amounts for shipping via U.P.S. Ground. Up to $50.00-add $5.75, $50.01 to $100.00-add $7.75, over $100.00-add 8% to total. Air freight is additional. Shipping charges apply to domestic US orders only. International orders will incur a $12 documentation charge and will be billed at actual cost plus associated duties and taxes. F.O.B Point: Niles, IL 60714

Sales Tax: We are expected to collect applicable sales tax on all purchases, including shipping and handling charges, sent to CO, FL, GA, MI, NM, NC, TN, TX, WI and on purchase totals only in CA, IA, IL, IN, OH, SC, and VA. Sales Tax Chart: CA 7.75%, CO 3.8%, FL 6%, GA 6%, IA 6%, IL 8.25%, IN 5%, MI, 6%, NC 6%, NM 5.82%, OH 7%, SC 6%, TN, 8.25%, TX 8.25%, VA 4.5%, and WI 5.5%.

What's New Software



CREATE AUDIOVISUAL PRESENTATIONS

ScreenCam for Windows release 2.0 ($99) includes captioning, 2-to-1 sound-compression, and editing functions. You can store up to 15 minutes of ScreenCam movies (without audio, using captions) on a floppy disk and save and distribute the movies as stand-alone executable files or as embedded OLE objects in documents. In addition, you can send ScreenCam presentations over a network via Lotus cc:Mail, Lotus Notes, Microsoft Mail, or Novell GroupWise and post them on BBSes, the Internet, on-line services, or in a Notes database.

Contact: Lotus Development, Cambridge, MA, (800) 343-5414 or (617) 577-8500.

Circle 1271 on Inquiry Card.

WINDOWS ACCESS FOR BLIND PC USERS

ScreenPower for Windows provides blind people with access to Windows applications. The program identifies every icon, button, scroll bar, and command element and makes them easy to find and operate. SPWin ($995) comes in Braille- and speech-only versions and is compatible with more than 30 speech synthesizers.

Contact: TeleSensory, Mountain View, CA, (800) 286-8484 or (415) 960-0920; E-mail: tele@netcom.com.

Circle 1276 on Inquiry Card.

32-BIT OS/2 IMAGE EDITOR ▼

ColorWorks for OS/2 ($495), a 32-bit multitasking application with a configurable tool architecture, yields thousands of possible drawing tools and a flexible way to define floated images. You can configure the drawing tools to allow you to draw with a color, an effect, or combinations of effects and use the tools to define masks for effects and transformations.



Contact: SPG, Miami Lakes, FL, (305) 362-6602; E-mail: 74723.3437@compuserve.com.

Circle 1275 on Inquiry Card.

MEMORY TECHNOLOGY FOR THE MAC OS

With OptiMem RAM Charger ($129), memory use becomes more efficient, flexible, and reliable. Applications open using smaller initial blocks, and an application's size in memory can grow and shrink after it is open.

Contact: Jump Development Group, Pittsburgh, PA, (800) 586-7622 or (412) 681-2692; E-mail: jumpdevgrp@aol.com.

Circle 1284 on Inquiry Card.

PRODUCTIVITY TOOLS FOR VISUAL BASIC

A set of 10 productivity tools, ToolThings ($179) takes the work out of developing Visual Basic applications. Each tool automates a common development task, so you can visually design windows, message boxes, and Windows common dialog boxes; precisely position, align, group, and resize controls; set the tab order for all controls on a form in one dialog box; indent lines of code; change blocks of procedural code to comments and vice versa; identify and remove unused routines, variables, and constants from your code; and call up a visual diagram of a user-defined function, user-defined type, or variable declaration and assign values to each element.

Contact: Pinnacle Publishing, Kent, WA, (800) 231-1293 or (206) 251-1900.

Circle 1290 on Inquiry Card.

WORDPERFECT DOCUMENT SPLITTER

SplitVu allows you to simultaneously view and edit two parts of a WordPerfect document. The program ($34.95) creates two window panes, each containing a separate view of the active document. You can separately scroll, search, edit, or work on the text in each pane, and all changes you make in either pane are reflected in the original document.

Contact: Bramblebush Software, New Canaan, CT, (800) 893-1117 or (203) 966-0198; E-mail: 73541.3470@compuserve.com.

Circle 1280 on Inquiry Card.

INCORPORATE YOUR BUSINESS

Incorporate takes you step-by-step through the process of incorporating. Based on forms and procedures obtained from state government offices, the Windows-based program ($69) creates valid documents for the 10 states in which more than 70 percent of all new corporations are formed. Incorporate also includes an introduction to corporate law.

Contact: Unabridged Software, Bellaire, TX, (800) 248-7630 or (713) 661-0044.

Circle 1281 on Inquiry Card.

WINDOWS-BASED DATA ACQUISITION SOFTWARE

When you use the Hydra Logger for Windows software with the Hydra data acquisition unit, you can control such functions as scanning, signal conditioning, sensor linearization, alarm sounding, nonvolatile memory, and trend plotting. An optional Trending package controls how the Hydra unit displays data. Hydra Logger for Windows' ($595; with Trending software, $995) Trending package can also calculate basic statistics and create *x*-bar charts and *x,y* scatter diagrams. It also lets you import data into a spreadsheet, zoom in on and isolate the desired data, and export only that portion to the designated spreadsheet.

Contact: Fluke, Everett, WA, (800) 443-5853 or (206) 356-5500.

Circle 1282 on Inquiry Card.

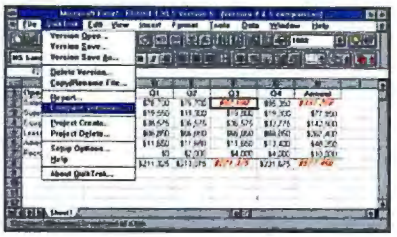


ENGINEERING VISUALIZATION ▲

MicroStation Masterpiece provides photo-realistic rendering, animation, advanced ray tracing, radiosity, engineering animation, and other visualization capabilities. The program ($1450), which is available in Windows, NT, Unix, and Power Mac versions, works with MicroStation Modeler, MicroStation V5, and MicroStation Review.

Contact: Bentley Systems, Exton, PA, (800) 778-4274 or (610) 458-5000; E-mail: sales@bentley.com.

Circle 1278 on Inquiry Card.



WINDOWS SPREADSHEET ▲ VERSION MANAGER

CCC QuikTrak automatically keeps track of the changes you make to a spreadsheet, why you made the changes, and how to get back to any prior version you choose. The program also provides comparison capabilities that allow you to quickly compare changes between versions and identify the impact of those changes. In addition, CCC QuikTrak ($99) saves disk-storage space by storing only the changes made between spreadsheet versions rather than duplicate copies of the entire file.

Contact: Softool, Goleta, CA, (800) 763-8665 or (805) 683-5777; E-mail: info@softool.com.

Circle 1283 on Inquiry Card.

ANALYZE AND MANAGE SERVER SPACE

A server-space analysis and management tool, FileWizard 3 has a Native Windows front end, Hierarchical Storage Management, and support for NetWare file servers with PC and Mac clients. The program (single server, $695) automatically migrates files according to a rule-based system and makes all migrated files available to users. Transparent access to the archive server lets users find and retrieve a file as though it were still in the primary location.

Contact: Knozall Systems, Chandler, AZ, (800) 333-8698 or (602) 545-0006; E-mail: gaill@tesi.com.

Circle 1285 on Inquiry Card.

IMPROVE YOUR ADA PROGRAMS

Asta's TCMON and TBGEN software-analysis and test systems improve the quality and performance of software programs written in Ada. The products (licenses, from $2300) identify performance bottlenecks, test coverage, and automatically test Ada Unix programs.

Contact: Asta, Nashua, NH, (800) 350-2782 or (603) 889-2230; E-mail: asta@delphi.com.

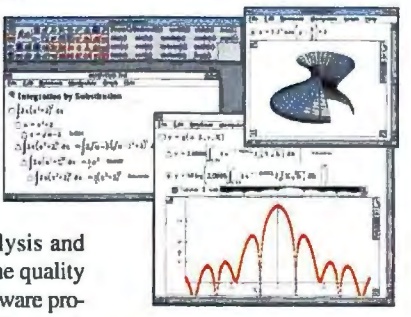
Circle 1298 on Inquiry Card.

MULTIPLATFORM SECURITY FOR UNIX

SeOs combines operating-system-level interception of security-sensitive events with an access-rules database. The program (server, $999; each client, $150) features a Kerberized Single Sign-On to the mainframe, which eliminates the transmission of passwords over a network, and lets you protect root ID and defend against Trojan horses and back doors.

Contact: Memco Software, New York, NY, (800) 862-2602 or (212) 286-8820; E-mail: dorin@memco.com.

Circle 1277 on Inquiry Card.



SOLVE EQUATIONS ▲

Theorist 2 for Windows 3.1 and NT provides numeric and symbolic computational tools, which it displays in real mathematical notation, for equation solving and mathematical exploration. More than a calculator, Theorist 2 (US$299) also handles algebraic equations and expressions and 2-D and 3-D graphing. The program is also available for Macs and Power Macs.

Contact: Waterloo Maple Software, Waterloo, Ontario, Canada, (800) 267-6583 or (519) 747-2373; E-mail: info@maplesoft.com.

Circle 1288 on Inquiry Card.

Software Update

Conversions Plus 3.0, a Windows utility that lets you use Mac disks in your PC and convert files back and forth, includes new translators, enhanced graphics capabilities, and a file-preview feature. $149.

Contact: DataViz, Trumbull, CT, (800) 733-0030 or (203) 268-0030; E-mail: d0248@applelink.apple.com.

Circle 1300 on Inquiry Card.

With **SafE Mail 1.02 for DOS,** you can safely encrypt or decrypt information in almost any format. The program creates output files with Internet-format compatibility and provides an electronic signature protocol, which is for exchanging presigned mail, and distortion protection that you can increase for low-quality transmission facilities. Single copy, $199; two-user pack, $349; four-user pack, $599.

Contact: Pinnacle Systems International, Cary, NC, (919) 469-9002.

Circle 1301 on Inquiry Card.

SCSI-Share 2.0, which lets you share SCSI devices over AppleTalk LANs, features completely overhauled emulation for virtual devices and full support of Apple's SCSI Manager 4.3. $89.

Contact: Stalker Software, Mill Valley, CA, (800) 262-4722 or (415) 383-7164; E-mail: info@stalker.com.

Circle 1305 on Inquiry Card.

ManagePro 3.0 for Windows, a program that helps managers set goals and deadlines, organize work, and manage people more effectively, offers customized reporting, job-specific templates, and Software Update expanded project and action management. $279.

Contact: Avantos Performance Systems, Emeryville, CA, (800) 282-6867 or (510) 654-4600; E-mail: avantos@america.online.com.

Circle 1303 on Inquiry Card.



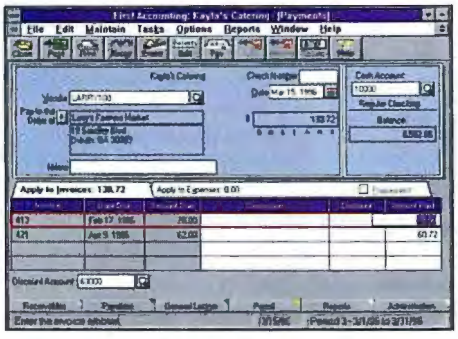
TRACK DOWN 6000 VIRUSES

Dr. Solomon's Anti-Virus Toolkit 7 (single-user Windows version, $125; single-user OS/2 version, $149) detects more than 6000 computer viruses, including complex encrypted and polymorphic viruses. The program scans inside files you've archived and compressed with PKZip, ARJ, PKLite, and LZExe. A NetWare NLM version offers NetWare 4 compatibility, optional server-based scanning, and administration from either the server console or a Windows client on a workstation.

Contact: S&S Software International, Burlington, MA, (617) 273-7400.

Circle 1272 on Inquiry Card.

What's New Software



ENTRY-LEVEL ACCOUNTING ▲

The Peachtree First Accounting program ($169) includes general-ledger, accounts-receivable, invoicing, accounts-payable, item-tracking, checking-account-reconciliation, job-tracking, and business-reporting features. It also lets you enter and print payroll checks and import data from Quicken. Peachtree First's Setup Checklist tells you how to customize your books to best fit your business's needs.

Contact: Peachtree Software, Norcross, GA, (800) 228-0068 or (404) 564-5700.

Circle 1292 on Inquiry Card.

DEVELOP NEURAL-NETWORK SOLUTIONS

NeuralWorks Predict 1.0 ($995) uses fuzzy logic, genetic algorithms, dynamic hill climbing, Kalman filtering, and conjugate-gradient methods to help you develop sophisticated neural-network solutions. Once you develop a model, Predict provides facilities for testing it, running it within Microsoft Excel for Windows, and deploying it as a C, Visual Basic, or FORTRAN program.

Contact: NeuralWare, Pittsburgh, PA, (412) 787-8222; E-mail: sales@nware.com.

Circle 1279 on Inquiry Card.

NEW APPROACH TO PROJECT MANAGEMENT

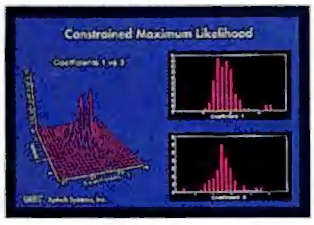
Artemis ResourceView (call for prices), a client/server-based resource management tool, consists of two modules: Requester and Allocator. Requester allows you to define new work requests and send them to the appropriate managers for scheduling and commitment. You can directly enter work requests into Artemis ResourceView or import them from Artemis Prestige or Microsoft Project. The Allocator module allows managers to assign approved tasks to resources.

Contact: Lucas Management Systems, Fairfax, VA, (800) 477-6648 or (703) 277-1050; E-mail: cfinch@lucasmgt.com.

Circle 1289 on Inquiry Card.

GAUSS APPLICATIONS ▼

Constrained Maximum Likelihood's (Unix version, $995; PC version, $495) features include the ability to solve general maximum-likelihood problems using the sequential quadratic programming method; linear and nonlinear constraints on parameters; equality and inequality constraints on parameters; confidence limits for constrained



problems; bootstrapping with histogram and surface-plot output; likelihood-profile trace plots; weight observations; and the ability to profile *t* plots and fix selected parameters.

Constrained Optimization (Unix version, $495; PC version, $245) solves standard nonlinear programming problems using the sequential quadratic programming method and provides the capability of adding linear, nonlinear, equality, and inequality constraints on parameters.

Contact: Aptech Systems, Maple Valley, WA, (206) 432-7855; E-mail: info@aptech.com.

Circle 1293 on Inquiry Card.



LOW-COST WINDOWS PUBLISHING SUITE

An all-in-one desktop publishing and graphics solution, Serif Publishing Suite helps you produce professional-quality black-and-white or color-separation newsletters, ads, brochures, catalogs, and greeting cards. The package ($199) includes PagePlus, a desktop publisher with Pantone Color Matching, text wrapping, and three levels of operation (Intro, Publisher, and Professional); WritePlus, a word processor; DrawPlus, a vector illustration module for creating and editing WMF clip-art files; PhotoPlus, an image-effects module for TWAIN and Kodak Photo CD files; TypePlus, for text effects and logo creation; TablePlus, for table editing and mini-spreadsheets; and Fonts & Clipart, a library of typefaces and images.

Contact: Serif, Nashua, NH, (800) 697-3743 or (603) 889-8650; E-mail: serif@mv.mv.com.

Circle 1273 on Inquiry Card.

Software Update

StarManager Advanced 4.0, a Windows program for sales-territory design and mapping, supports more data formats, including ODBC, and mapping and realignment down to the individual account level; it also provides up to 20 user-definable variables in the StarManager database, up to 20 layers of map detail, and a drag-and-drop feature that lets you quickly grab and realign territory geography and accounts. From $995.

Contact: TTG, Woburn, MA, (617) 932-6500.

Circle 1302 on Inquiry Card.

The 32-bit version of the **Formula One** spreadsheet component includes the ability to create and format objects on worksheets; an enhanced calculation engine; worksheet zooming; print scaling; the ability to read and write Microsoft Excel 4.0 worksheets; special classes for C++ developers to handle worksheet and window creation and manipulation, message routing, and events; and window-manager functions for C developers. $249.

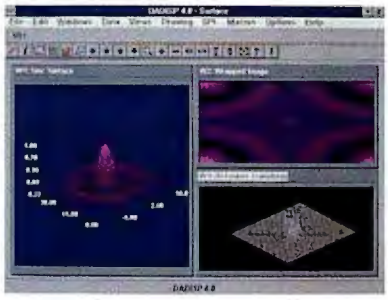
Contact: VisualTools, Lenexa, KS, (800) 884-8665 or (913) 599-6500.

Circle 1306 on Inquiry Card.

Software Sentry 2.0, a network-independent license-metering and software-asset management tool, comes with a virus checker and the ability to automatically load the TSR into expanded memory. Alerts notify the LAN administrator of low-license conditions and help-desk requests. Multilingual client support provides international user-intercept messages and end-user help text in English, French, German, Italian, or Spanish. Per server: 50 users, $295; 100 users, $595; 250 users, $895.

Contact: Microsystems Software, Framingham, MA, (800) 489-2001 or (508) 879-9000; E-mail: info@microsys.com.

Circle 1307 on Inquiry Card.



Contact: Modatech Systems, Vancouver, BC, Canada, (800) 804-6299 or (604) 736-9666; E-mail: brn@modatech.com.

Circle 1295 on Inquiry Card.

GRAPHICAL DATA ANALYSIS ▲

DADiSP 4.0 (PC version, $1895; workstation version, $2995), a graphical data-analysis package, includes native GUI standards; DDE and other interprogram communications; and SPL (Series Programming Language), which provides user-defined functions, looping and iteration, conditional statements, array references, and variables. SPL also includes Hot Variables, which can contain complex numbers, real numbers, integers, and strings, as well as data series and matrices.

Contact: DSP Development, Cambridge, MA, (800) 424-3131 or (617) 577-1133; E-mail: dspdev@world.std.com.

Circle 1297 on Inquiry Card.

CONTACT MANAGEMENT

The OLE support in Maximizer 3.0 for Windows enables you to attach objects, such as spreadsheets and documents, to clients and contacts. Once they're linked, you can modify, print, search, and archive objects from within Maximizer. In addition to printing documents, reports, labels, and envelopes, Maximizer 3.0 ($249) can print in popular address- and calendar-book formats. The software's new scheduling features include conflict checking, a find-free-time feature, and an option to add a follow-up task or appointment.

MULTIMEDIA NOTES ANYWHERE

A Windows-based annotation utility, E•Glue 2.0 lets you annotate documents and Windows applications with electronic stick-on notes that can contain text, sound, video, graphics, and animations. Version 2.0 (single-user version, US$69.95) features templates, pop-up notes, and a self-resizing notepad. The program's network compatibility lets you send notes to other users with Microsoft Mail or cc:Mail using your existing post office.

Contact: The Plant Software, North Vancouver, BC, Canada, (604) 986-6121; E-mail: info@theplant.com.

Circle 1291 on Inquiry Card.

ENGLISH/SPANISH ACCOUNTING

The Business Accountant Gold integrates receivables, payables, and payroll into one system. The DOS-based program also helps in budgeting, financial planning, decision making, and tax preparation. The program ($99) saves each transaction to your disk and closes your books as soon as you enter a transaction, keeping your books always up-to-date. From any menu, you can switch from Spanish to English or from English to Spanish.

Contact: Brilliant Nite Software, McLean, VA, (800) 991-1997 or (703) 883-3700; E-mail: dmr@netcom.com.

Circle 1286 on Inquiry Card.

SCHEMATIC DESIGN TOOL FOR WINDOWS 3.1 AND NT

You can design schematics with WinDraft ($750), a 32-bit application that lets you scale components using the Plus or Minus key before placement and automatically places junctions when you end a wire on another wire. You can also edit any part's pin name from the schematic editor without having to go through the library editor.

Contact: Ivex Design International, Beaverton, OR, (503) 531-3555; E-mail: info@ivex.com.

Circle 1296 on Inquiry Card.

INTERACTIVE ON-LINE SOFTWARE

Worldgroup ($795) unifies messaging, workgroups, customer service, sales, support, EDI, and the Internet. For callers, Worldgroup offers E-mail, group-messaging forums, file libraries, multiuser teleconferencing, polls, and questionnaires. The client software can access the server over a dial-up modem or through the Internet. From inside a company, the employees can log on through a LAN using Novell IPX/SPX or TCP/IP protocols.



Contact: Galacticomm, Fort Lauderdale, FL, (800) 328-1128 or (305) 583-5990; E-mail: sales@gcomm.com.

Circle 1274 on Inquiry Card.

Software Update

VToolsD 1.1 for Windows 3.1, a VxD (virtual device driver) toolkit for C and C++, lets you build VxDs targeted for Windows for Workgroups 3.11; supports the WFW 3.11 features that will be implemented in Windows 95; and introduces PELE, a utility that lets you create VxDs with the 32-bit Borland C++ compiler. $495.

Contact: Vireo Software, Bolton, MA, (508) 779-8352; E-mail: vireo@vireo.com.

Circle 1308 on Inquiry Card.

PICS 1.5 provides doubled speed of the hierarchical listbox, a TimeEdit control that automatically starts and stops time, international date/calendar control, and numeric edit control. The Percent Bar control displays the percent-completed status of an ongoing process, and the Volume Dial control lets you turn a knob-like stereo control to increase or decrease a parameter. $149; source code version, $495; PICS NT version, $495; source code NT version, $995.

Contact: ProtoView Development, Dayton, NJ, (800) 231-8588 or (908) 329-8588.

Circle 1319 on Inquiry Card.

Electronics Workbench 4.0 lets you simulate analog, digital, and mixed-mode circuits; in addition, you can create larger and more complex circuits with components in multiple parts bins and over 350 real-world models. The program also provides A/D and D/A converters; variable resistors, capacitors, and inductors; encoders, decoders, multiplexers, and demultiplexers; and 74xx and 74xxx ICs. $299.

Contact: Interactive Image Technologies, Toronto, Ontario, Canada, (800) 263-5552 or (416) 977-5550; E-mail: ewb@interactiv.com.

Circle 1310 on Inquiry Card.

Reaching for a New Frontier



Having trouble keeping up with the ever-changing world of technology? Quatech can help. We are committed to providing our customers with quality products and exceptional service and support. We manufacture a complete line of communication and data acquisition products for PC/XT, PC/AT, PS/2, and PCMCIA systems. Just tell us your application, and we'll find the solution that's right for you.

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Communication boards for ISA and Micro Channel meet synchronous, asynchronous, serial, and parallel communication requirements with protocols such as RS-232, RS-422, RS-485, Current Loop, and IEEE-488. Intelligent and coprocessor adapters are also available. Data acquisition products add analog to digital, digital to analog conversions, and digital I/O capabilities in 8 to 16-bit resolution. Other boards provide the capabilities for digital multimeters, digital frequency synthesizers, arbitrary waveform synthesizers, and IEEE-488 GPIB interfaces.

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NEC 4Xe	479.88
NEC 4Xe Kit	549.25
NEC 6Xi	496.14
NEC 6Xe	547.56
Pioneer DRM604X 4X 6 disc	804.71
Pioneer DRM1804X 4X 18 disc	1879.23
Plextor 4plex quad external	589.88
Plextor 4plex quad internal	499.84
Plextor 6X internal	499.87
Sigma Designs RealMagic Lite	289.93
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Sigma Designs RealMagic CD Kit	659.41
Sony CDU-55E 2X internal	119.84
Sony CDU-55S SCSI 2X internal	166.97
Sun Moon Star CD 2X kit internal	149.78
Sun Moon Star CD 2X kit internal w/sound	211.78
Teac SuperQuad 4X internal	294.52
Toshiba 3601 SCSI 4X internal	309.86
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Versa M 4/75 340MB dual clr	3142.66
Versa M 4/75 340MB act clr	3755.78
Versa M 4/75 340MB true clr	4039.85
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Versa M 4/100 540MB hi-res color	4745.20
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SMART 1400 LAN	569.41
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T2100

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Processor	Screen	HD	Price
486DX2/50	9.5" Mono	250MB	$1439
486DX2/50	10.4" Dual Scan	330MB	2249
486DX2/50	8.4" Active	330MB	3099

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- Built-in AC adapter - small, sleek design & reduced weight
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Processor	Screen	HD	Price
486DX4/75	10.4" Dual Scan	500MB	$3539
486DX4/75	10.4" Active	500MB	4679

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- 10.4" Active Matrix display
- Built-in 16-bit sound, microphone, speaker & MIDI

Processor	Screen	HD	Price
Pentium 75	10.4" Active	772MB	$5499

Other Notebooks from Toshiba

Processor	Screen	HD	Price
T4800CT			
4B6DX4/75	9.5" Active	500MB	$3559
T4850CT			
486DX4/75	10.4" Active	500MB	$3889
486DX4/75	10.4" Active	772MB	4099
T3600			
486DX2/50	8.4" Active	500MB	$3719

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NEC



Versa P

Versa M

- High Res. displays available - 800x600 res. on notebook
- True color displays available-16.7 million colors on notebook
- Removable/Reversible display
- Replace floppy w/ 2nd battery for 6-10 hrs. battery life
- Replace floppy w/ Versa Bay - Add extra PCMCIA
- Built-in 16-bit sound, microphone & speaker
- Upgradable hard drive - easily add more storage

Processor	Screen	HD	Price
486DX4/75	9.5" Dual Scan	250MB	$3049
486DX4/75	9.5" Dual Scan	340MB	3119
486DX4/75	9.5" Active	340MB	3739
486DX4/75	9.5" Active	540MB	3999
486DX4/75	9.5" True Color	340MB	3999
486DX4/75	9.5" High Res.	540MB	4399
486DX4/100	9.5" Active	340MB	4069
486DX4/100	9.5" True Color	540MB	4629
486DX4/100	9.5" Active	810MB	4729
486DX4/100	9.5" High Res.	540MB	4729
486DX4/100	9.5" High Res.	810MB	5099

Versa P

- 75MHz Pentium - for blazing performance
- High Res. displays available - 800x600 res. on notebook (10.4" on selected models)
- Removable/Reversible display
- Replace floppy w/ 2nd battery for 6-10 hrs. battery life
- Replace floppy w/ Versa Bay - Add extra PCMCI
- Built-in 16-bit sound, microphone & speaker
- Upgradable hard drive - easily add more storag

Processor	Screen	HD	Price
Pentium 75	9.5" Active	340MB	$4349
Pentium 75	9.5" Active	540MB	4629
Pentium 75	9.5" Active	810MB	4999
Pentium 75	9.5" High Res.	540MB	4999
Pentium 75	9.5" High Res.	810MB	5389
Pentium 75	10.4" Active	540MB	4999
Pentium 75	10.4" Active	810MB	5389
Pentium 75	10.4" High Res.	810MB	5769

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TravelMate 4000M Shown with optional Docking Station



75MHz Pentium with PCI BUS



TravelMate 5000

TravelMate 4000M

- Brilliant color display
- 16-bit sound card
- Integrated pointing device
- 2 Type II or 1 Type III PCMCIA slot

Processor	Screen	HD	Price
486DX2/50	9.5" Dual Scan	340MB	$2119
486DX2/50	8.4" Active	455MB	2379
486DX4/75	9.5" Dual Scan	455MB	2459
486DX4/75	8.4" Active	340MB	2729
486DX4/75	8.4" Active	455MB	2979
486DX4/100	9.5" Active	525MB	3939

TravelMate 5000

- 10.4" Active Matrix display w/ 2MB Video RA
- 10.5" Dual Scan display with 2MB Video RA
- 65K colors on notebook display
- Built-In Dual Lithium Ion Batteries
- 16-bit Sound Card, Speaker, Microphone & MIDI
- User Replaceable 772MB Hard Drive (Active
- User Replaceable 500MB Hard Drive (Dual Scan)
- Infrared port for wireless connections

Processor	Screen	HD	Price
Pentium 75	10.5" Dual Scan	500MB	$4999
Pentium 75	10.4" Active	772MB	5599

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Ascentia 810N

Ascentia 910N

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- Lithium Ion battery technology
- Intelligent power management to maximize performance
- Integrated Smartpoint - small, accurate & easy to use

Processor	Screen	HD	Price
486DX2/50	10.3" Dual Scan	340MB	$2559
486DX4/75	10.3" Dual Scan	510MB	2749
486DX4/75	10.4" Active	510MB	3829
486DX4/75	10.4" Active	700MB	4129

Ascentia 810N

- 486DX2/66 processor – to speed through your applications
- 10.4" Dual Scan display
- Replace floppy w/ 2nd battery for 4-6 hrs. battery life

Processor	Screen	HD	Price
486DX2/66	10.4" Dual Scan	250MB	$1969
486DX2/66	10.4" Dual Scan	340MB	2109
486DX2/66	10.4" Dual Scan	510MB	2259

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- Built-in infrared

Processor	Screen	HD	Price
486DX4/100	10.4" Dual Scan	340MB	$4099
486DX4/100	10.4" Dual Scan	540MB	4449
486DX4/100	10.4" Dual Scan	810MB	4899
486DX4/100	10.4" Active	340MB	4999
486DX4/100	10.4" Active	540MB	5349
486DX4/100	10.4" Active	810MB	5799
486DX4/100	10.4" Active	540MB	6349*
486DX4/100	10.4" Active	810MB	6799*

*Features Built-In CD-ROM drive

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Processor	Screen	HD	Price
IBM ThinkPad® 360 & 360E			
486SL/33	8.4" Active	340MB	$1999
486DX2/50	9.5" Dual Scan	340MB	2699
486DX2/50	9.5" Dual Scan	540MB	3049
486DX2/50	8.4" Active	340MB	3099
486DX2/50	8.4" Active	540MB	3449

Processor	Screen	HD	Price
IBM ThinkPad® 701			
486DX2/50	10.4" Dual Scan	360MB	$3799
486DX2/50	10.4" Dual Scan	540MB	4149
486DX2/50	10.4" Active	360MB	4799
486DX2/50	10.4" Active	540MB	5149
486DX4/75	10.4" Dual Scan	360MB	4399
486DX4/75	10.4" Dual Scan	540MB	4749
486DX4/75	10.4" Active	360MB	5299
486DX4/75	10.4" Active	540MB	5649

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LTE Elite

Contura 410

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- 32-bit local bus with 1MB video RAM
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Processor	Screen	HD	Price
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486DX2/50	8.4" Active	350MB	2839

LTE Elite

- 10.4" Active Matrix display
- Fast 486DX4/75 processor
- Built-in AC adapter - small, sleek design & reduced weight
- Upgradable hard drive - easily add more storage

Processor	Screen	HD	Price
486DX4/75	9.5" Dual Scan	340MB	$3129
486DX4/75	9.5" Dual Scan	510MB	3499
486DX4/75	10.4" Active	510MB	5029
486DX4/75	10.4" Active	810MB	5389

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Processor	Screen	HD	Price
HP OmniBook 600 Notebook PC			
486DX2/50	8.5" Dual Scan	170MB	$2549
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486DX4/75	8.5" Dual Scan	170MB	3099
486DX4/75	8.5" Dual Scan	260MB	3379

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HP OmniBook 4000

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- Built-in 16-bit sound, microphone & speaker
- Replace floppy w/ 2nd battery for 5-7 hrs. battery life
- Built-in infrared for no hassle printer connections

Processor	Screen	HD	Price
486DX2/50	10.3" Dual Scan	260MB	$2499
486DX2/50	10.3" Dual Scan	340MB	2829
486DX2/50	10.3" Dual Scan	520MB	3199
486DX2/50	10.4" Active	340MB	3769
486DX2/50	10.4" Active	520MB	4129
486DX4/100	10.3" Dual Scan	340MB	3619
486DX4/100	10.3" Dual Scan	520MB	3999
486DX4/100	10.4" Active	340MB	4489
486DX4/100	10.4" Active	520MB	4829

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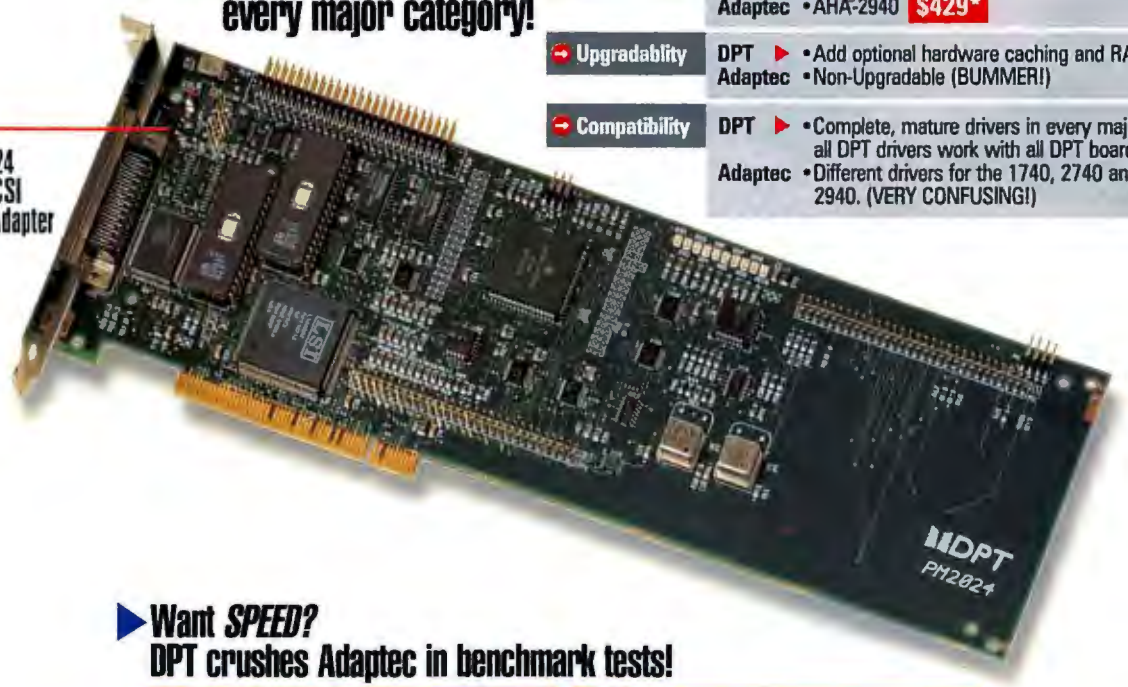
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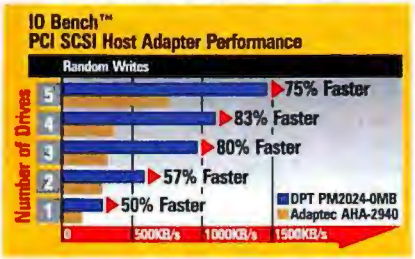
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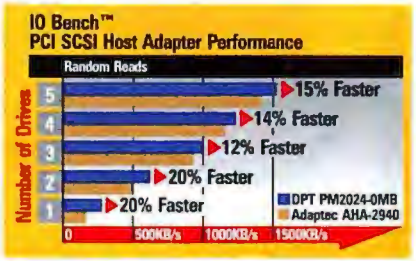
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2700	730MB	10MS	3.5" IDE	232
2850	850MB	10MS	3.5" IDE	265
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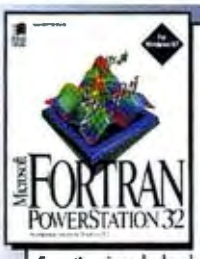
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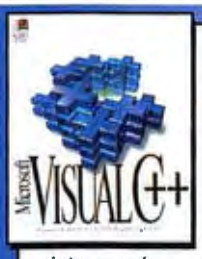
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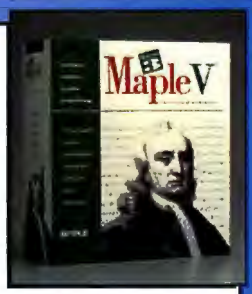


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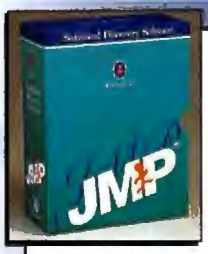
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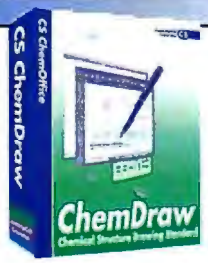
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	32Meg	500987-005	958.00
Premmia LX P/60, MX/466d, 4/100T, P/60	8 Meg	500987-003	338.00
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	64 Meg	501569-001	Call
Premmia 4133, 4133S, 4/50s, 4/50d	8 Meg	501159-002	338.00
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Manhattan G, V Series Server	64 Meg	501159-005	2298.00
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Bravo 486/25, 486/33	2 Meg Kit	500780-005	118.00
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Concerto LTE Elite	4Meg	144790-001	189.00
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Contura 320 325	2Meg	139497-001	99.00
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T2000SX/E/2200SX/T1800 1850, C	4Meg	PC-PA2001U	189.00
T2000SX/E/2200SX/T1800 1850, C	8Meg	PC-PA2002U	359.00
T2100, 2105, 2150	4Meg/8Meg		199/389
T2100, 2105, 2150	16Meg/24Meg		779/1169
1440/2S/X 3400 T6400 T6600	4Meg	PC-PA2004U	189.00
1440/2S/X 3400 T6400 T6600	8Meg	PC-PA2005U	359.00
1440/2S/X 3400 T6400 T6600	16Meg	PC-PA2006U	719.00
T4500 2, 4400 T1800 T1850 C T1910, T1950 (3.3 v)		PC-PA2112U	129.00
T4500 2, 4400 T1800 T1850 C T1910, T1950 (3.3 v)		PC-PA2113U	399.00
T4500 2, 4400 T1800 T1850 C T1910, T1950 (3.3 v)		PC-PA2114U	799.00
T4700, 4800, 4900 (Hard Drive)	32Meg/72Meg		949/1149
T3400CT, T3400C, T3600	4Meg	PC-PA2010U	154.00
T3400CT, T3400C, T3600	8Meg	PC-PA2011U	314.00
T3400CT, T3400C, T3600	16Meg	PC-PA2012U	707.00
T3400CT, T3400C, T3600	32Meg		1549.00
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T3200SX	4Meg	PC1PA8307U	85.00
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ALR Venture	4Meg	12467380	149.00
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Altima Virage II	4Meg/8Meg/16Meg		169/369/679
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AST Notebook Prem Exec 386SX/20/25/25L	4Meg	600814-003	189.00
AST Power Exec 3/33C, 4/25EL, 4/25SL	4Meg/16Meg	801166-001, -003	199/679
AST Power Exec 4/33SL	4Meg/16Meg	501318-001 002	199/679
AT&T Globalyst 200	4Meg/8Meg/16Meg		199/379/679
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AT&T Safari NSX 25	4Meg/8Meg/16Meg		Call
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Epson ActionNote 700, 700c, 700cx	4Meg/16Meg		199/639
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NEC 90 290	–	–	119	189	239	–	–	–	–	–	–	–
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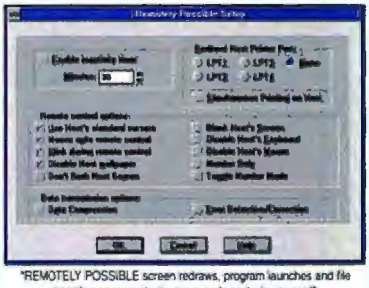
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	4MB	N/A	$198
	16MB	N/A	$648
PS/1 and 386/SX (2121)	2MB	92F9935	$88
	4MB	92F9694	$198
PS/2 30/286:25/286;			
Adpt Brd 1497259	512K	30F5348	$35
	2MB	30F5360	$98
PS/2 35SX, LS, 40SX,70-E61; 061; 121, Adpt Brd 6450609; 34F3011; 34F3077, 502, 55SX, 6555SX, P70, 55LS, 65LS X Station120 & 130	1MB	6450603	$39
	2MB	6450604	$94
PS2 50, 50Z, 55SX, 60, 65SX	2-8MB	1497259	$198
	2-16MB	6450609	$368
PS/1 Consultant, Essentials & Expert models x43, x44 & PS/Valuepoint all models except Cxx series			
	4MB	96F9290	$198
	16MB	96F9291	$598
PS/2 70-A21; A61; B21; B61; PS/1 Consultant, Essential & Expert models x11, x13 & x14, PS/Valuepoint Cxx series			
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	16MB	6060379	$647
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	8MB	8189099	$398
	16MB		$848
CL57SX	4MB	07G1420	$208
Thinkpad 700, 700C, 720, 720C, 750C			
	8MB	07G1421	$378
	16MB	6665109	$898
Thinkpad 710T	4MB	N/A	$188
	8MB	N/A	$318
PS/Note N45SL	2MB	92F6804	$106
PS/2, N51, SLC, SX	2MB	07G1826	$98
	4MB	07G1827	$188
	8MB	07G1828	$418
Laptop N33SX, L40SX & PSNOTE 182			
	2MB	79F0999	$98
	4MB	79F1000	$184
L40SX, PSNOTE 182 ONLY	8MB	79F1001	$358

AST COMPUTER MEMORY

MODEL#	MEMORY	PART#	PRICE
PREMMIA	4MB	501159-001	$188
	8MB	501159-002	$368
	16MB	501159-003	$768
ADVANTAGE 386SX/20,25, PRO SX/25 BRAVO 3/33S	2MB	500962-001	$88
	8MB	500962-002	$348
BRAVO NB486	4MB		$198
	16MB		$798
ADVANTAGE PRO 486DX/33,SX/25, BRAVO LC 4/25S; 33; 33S; 50D; 4'66D	2MB	500987-001	$88
	4MB	500987-002	$164
	16MB	500987-004	$578
PREMIUM 386/25; 33; 33T II 386SX/16;20;25	1MB	500780-003	$48
	1MB	500780-002	$48
ADVANTAGE 486/25; 33,33P,SX20, BRAVO 4/33; 486/25, PREMIUM 4/25, 33TE, SE 4/33ZMB500718-004	2MB	500780-005	$68
ADVANTAGE 486/25;33;33P,SX20,POWER PREMIUM 3/33,4 33; 33S; 50D;66D; PREMIUM 386/33TE, 486/25;E; 25TE; 33; 33TE; PREMIUM II 386/25; 33, 486/33, 486SX/20PREMIUM SERVER SE 4/33	4MB	500780-004	$178
	8MB	500780-001	$398

AST LAPTOP

POWER EXEC 3/25SL, 3/25SL C,EL	4MB		$178
	16MB		$768
POWER EXEC 4/25SL/33SL	4MB		$178
	16MB		$688
PREMIUM EXEC 286,386SX/20;25;25C	4MB		$178
BRAVO NB486	4MB		$188
	16MB		$668
ASCENTIA 900N, 800N 4133-50-75	4MB		$198

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Compaq Memory

MODEL	MEMORY	PART#	PRICE
Deskpro 286E; 386-20; 20E; 25; 25E	1MB	113131-001	$59
	4MB	113132-001	$188
Deskpro 386S	4MB Board	113634-001	$254
	4MB Module	112534-001	$188
Deskpro 386-20E; 25E	4MB	113645-001	$238
Deskpro 386/33/33i; 486/25; 33L;50L; Systempro	2MB	115144-001	$108
	8MB	116561-001	$378
	32MB	116568-001	$1458
Systempro; Deskpro	6 SKT EXP BRD W/2MB	116569-001	$268
Compaq "M"	2-64MB	129160-001	$188
Deskpro 286N; 386N; 386SX/20; 20N, Portable 486c, Deskpro M , Systempro LT Series	129160-001, Pro		
Signia	1MB	118688-001	$49
	2MB	118689-001	$84
	4MB	118690-001	$168
	8MB	128877-001	$348
Prolina 3/25 & 25Z	2MB	141738-001	$88
	8MB	141742-001	$318
Prolina 4/25si, 4/33, 4/50ZMB Module		141683-001	$94
	4MB Module	141684-001	$178
	8MB Module	141685-001	$338
Compaq Pro Signia	16MB	149320-001	$684
	32MB	149147-001	$1524
DeskPro 5/60, 5/66M	8MB	149911-001	$388
Prosignia PC Server, 486/33/66	8MB	141685-001	$348
	16MB	149320-001	$648
	32MB	149147-001	$1498
Prosignia 5/60	16MB	149949-001	$698
Proliant 100 5/60	32MB	149912-001	$1398
Proliant 2000 4/30, 5/66	64MB	149913-001	$2698
Proliant 4000 4/50, 5/66	128MB	149914-001	$4495

Compaq Laptop & Notebook

Concerto 486	4MB		$188
	8MB		$358
	16MB		$698
Cocoara 320, 325, C	2MB	139497-001	$98
	4MB	139498-001	$174
	8MB	139499-001	$318
Contura 4/25CX	4MB	146520-001	$178
	8MB	146521-001	$338
	16MB	146532-001	$718
SLT/286	1MB	110235-001	$75
	4MB	110237-001	$218
SLT/386	1MB	118303-001	$79
	2MB	118304-001	$108
	4MB	118305-001	$198
Lte 286	1MB	117081-001	$79
	2MB	117081-002	$99
	4MB	117081-004	$178
Lte 386S/20	1MB	121125-001	$98
	4MB	121125-002	$208
Lte Lite/20, 25, 25C	2MB	129769-001	$138
	4MB	129769-002	$208
	8MB	129769-003	$388
	16MB	129769-004	$808
LTE Lite 486/25C	4MB	142337-002	$178
	8MB	142337-003	$348
	16MB	142337-004	$718
Aero 3.3volt	4MB	190532-001	$188
	8MB	190597-001	$358

Laser Printer Memory

MODULE	1MB	2MB	3MB	4MB	5MB	8MB
Canon LBP4, 4 Lite & 4+		$118		$164		
Canon LBP-430		$128		$228		
Epson Action Laser II, 8000	$88		$198		$308	
Epson + 6000 and many more		$128		$198		
Epson Action Laser 1000 & 1500		$98		$188		$399
Fujitsu 7100 & 7200	$199	$279				
HP Deskjet 500, 500C, 510, 550C and 560	$38 (256K)			$98		$164
HP 2, 2D		$98		$164		
HP 3, 3D, 3P, 2P, 2P+		$98		$168		
HP Laser Jet 4, 5Si, XL300, 1200C		$84		$168		$318
IBM Laser 4019, 4019E (3.5MB)		$114		$164		
IBM Laser 4029		$95		$155		
NEC 90, 290		$104				
NEC 95	$88					
OKI 400	$68	$88				
Packard Bell PB9500		$125		$208		
Panasonic 4410/4430		$118		$174		
Panasonic 4420/4450		$118		$178		
Panasonic 4450		$98				
Panasonic 4400/5400		$129		$198		
QMS 410		$119	$159		$249	
Toshiba Page Laser 6		$99		$168		
TI XL/PS17/PS35		$44	$98			

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MODEL	MEMORY	PART#	PRICE
T1000 SE/LE/XE	1MB	PA8311U	$29
T1000 SE/LE/XE	2MB	PA8312U	$73
T2000 / T2000SX	2MB	PA8317U	$73
T2000SX/T1000 LE	4MB	PA8314U	$188
	8MB	PA8315U	$358
T1200 XE	2MB	PA8306U	$98
T1600	2MB	PA8302U	$98
T2000 SXE/T2200SX/T1800 T1850, C	2MB	PA2000U	$78
	4MB	PA2001U	$198
	8MB	PA2002U	$358
T2400, T2450, T3600 3.3V	4MB	PA2019U	$218
	8MB	PA2020U	$398
	16MB	PA2023U	$798
T3100	2MB	PA7135E	$138
T3100 E	2MB	PA8341U	$108
T3100 SX	2MB	PA8308U	$108
	4MB	PA8310U	$188
T3200 SX	2MB	PA8307U	$118
	4MB	PA8309U	$198
T3200 SXC	2MB	PA8318U	$108
	4MB	PA8319U	$198
T3200	3MB	PA7137U	$184
T3300SL	2MB	PA2006U	$118
	4MB	PA2007U	$238
	6MB	PA2008U	$358
	16MB	PA2009U	$698
T3400CT	4MB	PA2019V	$218
	8MB	PA2020V	$399
	16MB	PA2021V	$758
T4400 SX, SXC, T6400 SXC, DXC	2MB	PA2003U	$125
	4MB	PA2004U	$198
	8MB	PA2005U	$358
	16MB	PA2010U	$698
	32MB		$1548
T4500, T4600, T1900C (3.3VOLTS) T4700	4MB	PA2012U	$198
	8MB	PA2013U	$388
	16MB	PA2014U	$858
T3100	2MB	PA8301U	$94
T3200/T5200C/T8500/TS400	2MB	PA8304U	$109
	8MB	PA8313U	$418

MAJOR LAPTOP & NOTEBOOK MEMORY

MODEL	MEMORY	PART#	PRICE
Acer Neos (All models)	4MB		$238
	8MB		$438
Canon Notejet 486	4MB		$238
All series	8MB		$418
Dell 320N, 212N NL25, NL20	2MB		$98
Dell Latitude	4MB		$198
	16MB		$698
Dec Notebook 425/433	4MB		$198
	16MB		$798
Epson Action Note	2MB		$122
	4MB		$218
Everex Tempo LX, LX20	2MB	00160	$98
Gateway 2000	4MB		$188
	16MB		$1475
Gateway 2000 486	4MB		$188
	16MB		$781
HP Omnibook	2MB		$96
	4MB		$208
Packard Bell, Magnavox, Minolta	1MB	N/A	$108
	4MB	N/A	$198
Panasonic CF170/270/370	1MB	CF-BA16S	$64
Panasonic CF580, V21P, V41	4MB		$218
	16MB		$896
Sanyo 17NB, 18NB & ZEOS	2MB	MBC-N8MEM2	$98
SHARP PC-7700, 7750	4MB		$198
8150, 8650, 8660	16MB		$698
SHARP PC8501	2MB		$108
TI Travelmate 2000	1MB	2568034-0011	$88
TI Travelmate 3000SX, WINSX	2MB	2566996-0001	$94
TI Travelmate 4000, WINDX/25 SX/16, SX25, DX2/50, DX2/40	4MB	2581265-001	$188
	16MB	AVAILABLE	$948

CACHE MEMORY

	12ns	15ns	20ns	25ns
8X8		5.95	5.75	5.45
32X8	12.00	8.95	7.75	6.55
64x1		10.95	7.05	6.95
64x4		10.00	7.95	6.95
16x4		6.95	6.45	5.95
128x8		54.00	34.00	27.00

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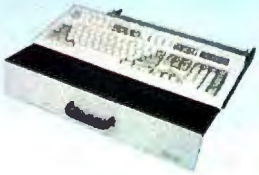
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ST32132A	1.05GIG	9MS	IDE	199
ST31230N	1.0GIG	9MS	IDE	575
ST32132A	2 GIG	9MS	IDE	999
ST31230N	2 GIG	9MS	SCSI	949
ST32132W	2 GIG	9MS	SCSI	949
ST31230N	2 GIG	9MS	SCSI	1850
ST32132W	4 GIG	9MS	SCSI	1679
ST34320W	4 GIG	9MS	SCSI	3099

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ST32155N	2 GIG	8MS	SCSI-2	1199
ST31150W	4.2GIG	8MS	SCSI-2	1699

Maxtor

FACTORY NEW-2 YEAR WARRANTY

M1426AV	425MB	12MS	IDE	$164
M1914AV	540MB	12MS	IDE	211
M1016AV	1 GIG	12MS	IDE	299
M1016AW	1 GIG	12MS	SCSI	349
M1914AA	540MB	11MS	IDE	219
M1914AS	540MB	11MS	SCSI	249
M1516AS	1.0GIG	11MS	SCSI	299
DP1641S	1.6GIG	9MS	SCSI	599
MaxtorMan1731	1.7GIG	10MS	PCMCIA	749
MaxtorMan1731	1.7GIG	10MS	PCMCIA	749

HARD DRIVES

CONNER

FACTORY NEW-1 YEAR WARRANTY

CFS420A	420MB	12MS	IDE	149
CFS540A	540MB	12MS	IDE	169
CFS1050A	1.0GIG	12MS	IDE	249
CFS1275A	1.2GIG	12MS	IDE	299
CFS1275S	1.2GIG	12MS	SCSI	349
CFS1275W	1.2GIG	12MS	SCSI	399
CFS2124S	2.1GIG	12MS	SCSI	599
CFS2124W	2.1GIG	12MS	SCSI	649
CFS3224W	3.2GIG	12MS	SCSI	1099

MICROPOLIS

FACTORY NEW-5 YEAR WARRANTY

MC1270	1.2GIG	9MS	IDE	299
MC1700	1.7GIG	9MS	IDE	399
MC2105	2.1GIG	9MS	IDE	499
MC2105	2.1GIG	9MS	SCSI	599
MC2700	2.7GIG	9MS	IDE	599
MC2700	2.7GIG	9MS	SCSI	699
MC4320	4.3GIG	9MS	SCSI	1099
MC4320	4.3GIG	9MS	SCSI	1099
MC5400	5.4GIG	9MS	SCSI	1599
MC5400	5.4GIG	9MS	SCSI	1599

FUJITSU

FACTORY NEW-5 YEAR WARRANTY

M2694EA	1.2GIG	12MS	IDE	299
M2694EA	1.2GIG	12MS	SCSI	349
M2694EA	1.6GIG	12MS	IDE	349
M2694EA	1.6GIG	12MS	SCSI	399
M2694EA	2.1GIG	12MS	IDE	399
M2694EA	2.1GIG	12MS	SCSI	449
M2694EA	2.5GIG	12MS	IDE	449
M2694EA	2.5GIG	12MS	SCSI	499
M2694EA	3.2GIG	12MS	IDE	499
M2694EA	3.2GIG	12MS	SCSI	549
M2694EA	4.3GIG	12MS	IDE	599
M2694EA	4.3GIG	12MS	SCSI	649

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120MB	15MS	IDE	$149
420MB	11MS	IDE	339
540MB	12MS	IDE	499
540MB	12MS	SCSI	499
1.2GB	12MS	SCSI	799

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IBM PS/2 INTERNAL DRIVE KITS
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210MB	IDE	$299
420MB	IDE	399
540MB	IDE	499
1.0GB	IDE	799

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FACTORY NEW-3 YEAR WARRANTY

AC2420	425MB	12MS	IDE	$163
AC2540	540MB	11MS	IDE	209
AC2700	730MB	10MS	IDE	274
AC2850	850MB	10MS	IDE	289
AC31200	1 GIG	10MS	IDE	399
AC31700	1.7GIG	10MS	IDE	439

digital

FACTORY NEW-5 YEAR WARRANTY

DSP3107	1GB	9.5MS	IDE	$694
DSP3210	2GB	9.5MS	IDE	1149
DSP5300	3GB	12MS	IDE	1299
DSP5400	4GB	12MS	IDE	2479

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FACTORY NEW-5 YEAR WARRANTY

C3323A	1.0GB	10MS	SCSI	$649
C2490	2 GB	8.9MS	SCSI	1079

IBM STANDARD

0677MB	17MS	SCSI	$265
0.68GB	17MS	SCSI	350
1.0GB	16MS	SCSI	549
1.01GB	8.6MS	SCSI	699
2.04GB	9.2MS	SCSI	1300
4.25GB	11MS	SCSI	2149
527MB	19MS	IDE	245
728MB	19MS	IDE	325
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Quantum

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LT365S	365MB	11MS	SCSI-2	186
LT540S	540MB	11MS	SCSI-2	243
MV540S	540MB	11MS	SCSI-2	228
LT541S	541MB	11MS	SCSI-2	243
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0664ESH	1.23GB	11MS	FH	2279

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ST31200W	1.05GB	8MS	3.5"	$749
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ST15150W	4.29GB	8MS	3.5"	2499

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MG4221	2.05GB	8.5MS	LP3.5	$1229
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486DX-33	145	239
486DX2-66	145	315
486DX-100	145	459

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MK2124FC	2.1GIG	15MS	IDE	
MK3240FC	3.2GIG	15MS	IDE	
MK1234FC	1.2GIG	15MS	IDE	
MK2124FC	2.1GIG	15MS	IDE	
MK3240FC	3.2GIG	15MS	IDE	
MK4322FC	4.3GIG	15MS	IDE	

IBM

WARRANTY 90 DAYS	120MB	15MS	IDE	650

Seagate

ST9120AG	120MB	16MS	IDE	$275
ST9160AG	170MB	16MS	IDE	275
ST9340AG	340MB	16MS	IDE	369
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1MB X 9-60NS 9 CHIP SIMM	46
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1EMB X 9-60NS SIMM	635
256K X 9-100NS SIMM	13
256K X 9-80NS SIMM	14
256K X 9-70NS SIMM	15
256K X 9-60NS SIMM	18
1MB X 9-80NS SIMM	40
1MB X 9-70NS SIMM	42
4MB X 9-80NS SIMM	135
4MB X 9-70NS SIMM	140
1MB X 9-80NS SIPP	43
1MB X 9-70NS SIPP	50
1MB X 9-60NS SIPP	51
256K X 9-80NS SIPP	18
256K X 9-60NS SIPP	18
256K X 9-70NS SIPP	20
256X36-1MB-70NS	65
512X36-2MB-70NS	85
1EM-4MB-70NS/80NS	185/175
4EM-16MB-70NS/80NS	535/545
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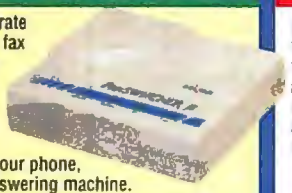
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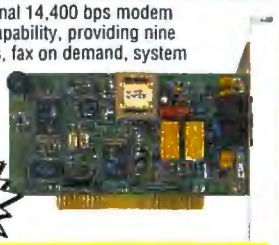
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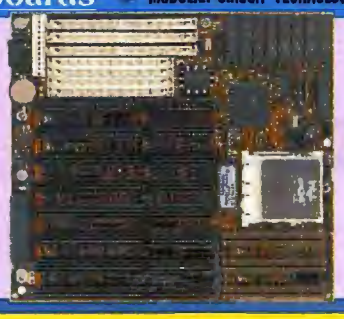


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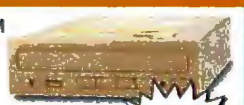
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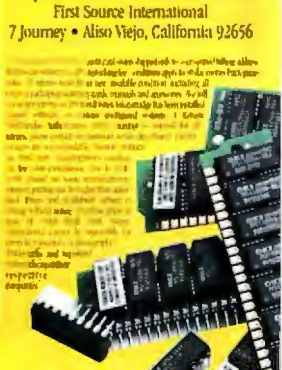
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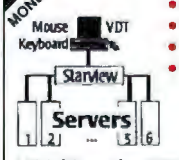
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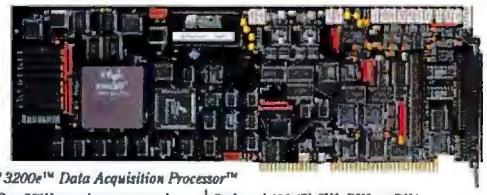
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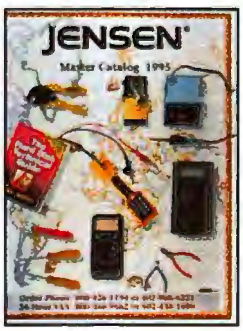
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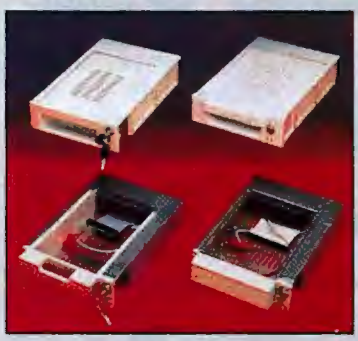
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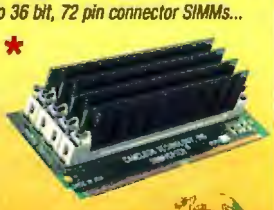
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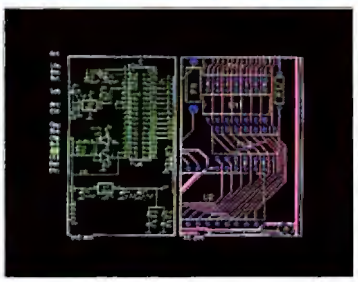


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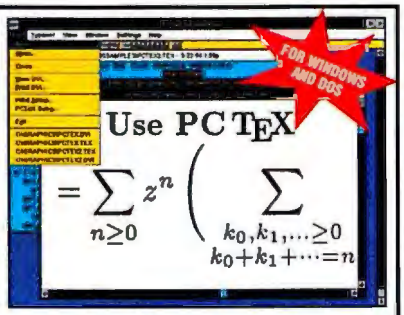
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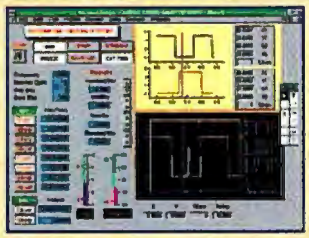
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ATM = After the Millennium

Are you holding your breath waiting for this next big thing? Better have a medical technician standing by.



MARK KOZLOWSKI © 1995

Are you getting as sick as I am of the daily announcements about ATM (asynchronous transfer mode) products? Or even worse, ATM-enabled products, whatever they might be. I mean, is anyone except a few universities and corporate pioneers actually using this stuff now, for real-world applications, all the time?

Doesn't this look like déjà vu all over again? It's just like when ISDN was announced in the early 1980s. When everyone was talking breathlessly about the integration of the computer and the telephone. When IBM bought—and then divested—Rolm.

Lest we believe that ATM is right around the corner, think first of the problems of moving to ATM, or for that matter to any other all-encompassing megatechnology. Interoperability issues are huge (we still have major interoperability issues with ISDN after 10 years of a supposedly established standard).

The cost of the ATM stuff is disproportionately high, and so are the connection and transport prices (all of which have been major issues stalling ISDN). Skills in installing, using, maintaining, and debugging ATM are nonexistent in the marketplace at large and will be for many years (just like ISDN again, even in the telephone companies themselves). Add to that the complexity of ATM-only networks, let alone heterogeneous networks, including everything from X.25 to video-on-demand.

In any case, why do normal people need ATM anyway? Isn't there more than enough of a choice out there? Frame relay, fast Ethernet, SMDS (Switched Multimegabit Data Service), not to mention ISDN. Unless you're transferring the entire MGM film library to every branch office in the world every day, aren't these older technologies going to cover just about everything you expect to do over the next few years? Is ATM a solution in search of a problem?

Even if ATM finds that killer problem this week, how long is it going to take to become a well-established standard? The telephone companies haven't done that with ISDN in 10 years. Let's be optimistic and say the pace of change has doubled—it will still be five years at least before ATM is established.

So why do we need ATM now? Is it the new corporate MIS status symbol to show that we're with it? Is ATM just the latest shot in the eternal class war, this time played out in that new frontier called cyberspace?

In the real world, the success of a technology is not a function of its engineering elegance. Witness the Concorde 20 or so years on. Ultimately, the test is whether or not the technology is appropriate—something we technofreaks tend to forget. ATM is clever. ATM is elegant. But is it appropriate? Right now it isn't.

What with the Internet, on-line services, and lots of PC-based communications methods and standards, cyberspace is fast becoming a protocol soup, where no one communications protocol dominates and newcomers are even less likely to do so. No one delivery protocol is going to take over the world of communications, nor should we want it to. We already have a delicious protocol soup with lots of ingredients that please many different palates. Some are gourmet, some are more basic. ATM is going to be just another, albeit gourmet, ingredient of the protocol soup, something to be enjoyed and savored by the technoliterati and the corporate titans while the peasants get by with the meat and potatoes of frame relay and ISDN.

The protocol soup that is communications today and tomorrow reflects a wide variety of demands and needs that the soup is by and large meeting. New ingredients will also be added: faster and longer Ethernets, ATM Lite, Son of Frame Relay, SMDS for TV, broad-ISDN, and so on. Each will meet the different needs of different users.

So you shouldn't just blindly jump on the ATM bandwagon. There's more to communications than fashion. Figure where you stand in the spectrum of needs and plan accordingly. Take into account the rich variety of existing methods that fit many needs very well and much more cheaply than ATM will. Leave the hard ATM stuff to others. Wait until it forms a real part of the communications environment and isn't just another brilliant but expensive technology waiting for its time in the sun. ■

Ted Prince is president of Perth Ventures and publisher of Technology Fundamentalist, *a newsletter that covers "winners and losers in information technology." You can reach him on CompuServe at 74073,1236 or on the Internet or BIX at editors@bix.com.*

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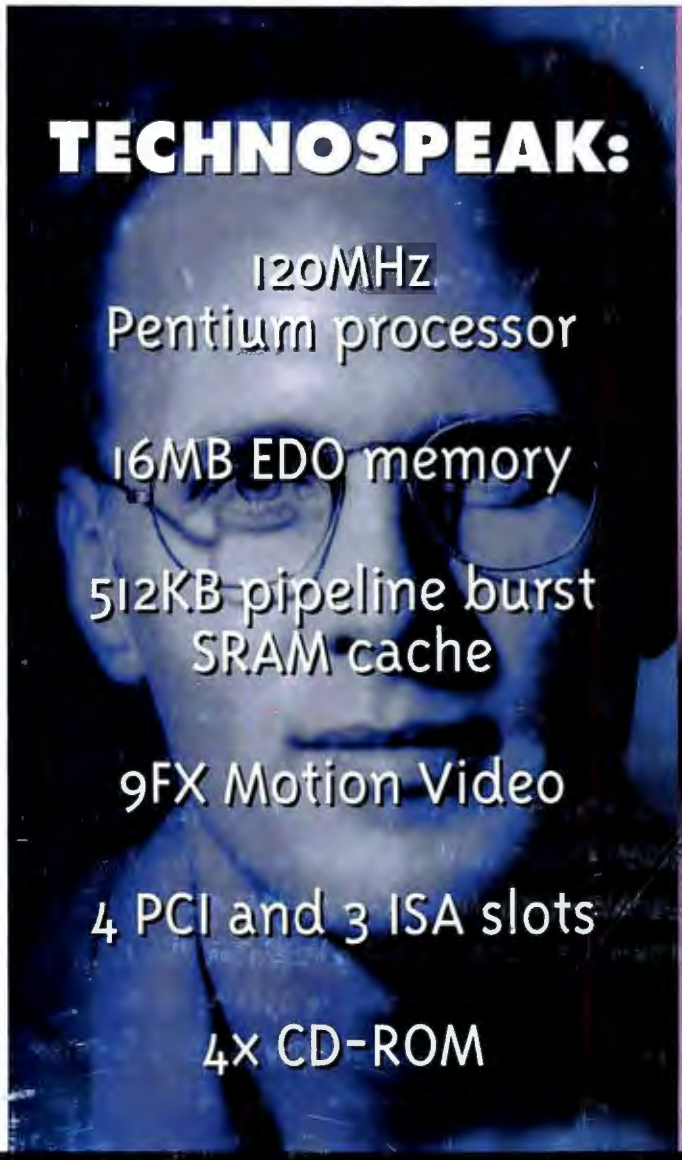
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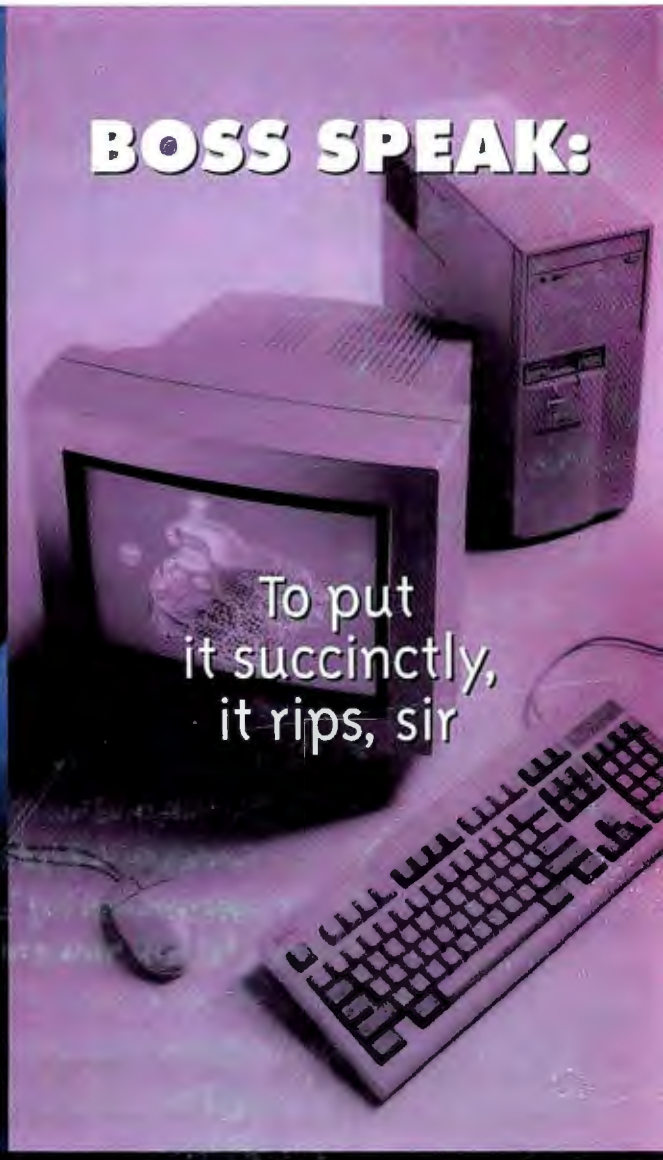
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